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ABBREVIATIONS

ac - acre(s)
AC - alternating current
a/f - acre-feet
ANFO - ammonium nitrate fuel oil
APS - Arizona Public Service
(aq) - aqueous or hydrated
ASW - administrative building, shop and warehouse
AT&T - American Telephone and Telegraph Company
AUM - animal unit month
BLM - Bureau of Land Management
BTU - British Thermal Unit
CFR - Code of Federal Regulations
cm - centimeter
db - decibels
DC - direct current
E - east
EIS - Environmental impact statement
E.O. - executive order
F - Fahrenheit
FP - fluorescent particle
g - gram
gpm - gallons per minute
HVDC - high voltage direct current
in. Hg. Abs. - inches of mercury absolute
km - kilometer
kv - kilovolt
LA - Los Angeles
LADWP - Los Angeles Department of Water and Power
LCC - load carrying capability
m - meter
maf - million acre-feet
MCFD - million cubic feet/day
MESA - Mine Enforcement and Safety Administration
mg/l - milligrams per liter
mph - miles per hour
MRI - Meteorology Research Inc.
MSFE - multi-stage flash evaporator
MSL - mean sea level
mw - megawatts
N - north
NRA - National Recreation Area
ohm - measure of electrical resistance
ORV - off-road vehicle
OSHA - Occupational Safety and Health Act
pCi/g - picocuries per gram
PDC - Kaiparowits Planning and Development Advisory Council
pH - measure of acidity, neutrality and basicity
P.L. - Public Law
pphm - parts per hundred million
ppm - parts per million
psi - pounds per square inch

R - range
R-O-W - right-of-way
RS - Revised Statutes
S - south
SCE - Southern California Edison
SCF - standard cubic foot
SDG&E - San Diego Gas and Electric Company
SLM - Salt Lake Meridian
SRP - Salt River Project
SSR - subsynchronous resource
Stat. - statutes
T - township
TDS - total dissolved solids
T/L - transmission line
tpa - tons per acre
tpd - tons per day
tph - tons per hour
tpy - tons per year
ug/m^3 - micrograms per cubic meter
U.S.C. - United States Code
W - west
WSCC - Western Systems Coordinating Council
10^6 - million

Chemical Abbreviations

$CaCO_3$ - calcium carbonate
$Ca(OH)_2$ - calcium hydroxide
$CaSO_3$ - calcium sulfite
$CaSO_4$ - calcium sulfate
CO_2 - carbon dioxide
CuO - copper oxide
$CuSO_4$ - copper sulfate
H_2 - elemental hydrogen
H_2O - water
H_2S - hydrogen sulfide
H_2SO_4 - sulfuric acid
$KAl_3(OH)_6(SO_4)_2$ - hydrous potassium aluminum sulfate
MgO - magnesium oxide
$Mg(OH)_2$ - magnesium hydroxide
$MgSO_3$ - magnesium sulfite
$MgSO_4$ - magnesium sulfate
Na_2SO_3 - sodium sulfite
$NaHSL_3$ - sodium bisulfite
NOx - nitrogen oxide
NO_2 - nitrogen dioxide
O_3 - ozone
S - elemental sulfur
SF_6 - sulfur hexafluoride
SO_2 - sulfur dioxide
SO_3 - sulfur trioxide
V_2O_5 - vanadium pentoxide

GLOSSARY

AASHO classification (soil engineering). The official classification of soil materials and soil aggregate mixtures for highway construction used by the American Association of State Highway Officials.

Acre-foot. The quantity of a material that will cover one acre of land one foot deep.

Adiabatic. Denotes a process (such as a parcel of air undergoing expansion or compression) in which there is no transfer of heat energy into or out of the system.

Adiabatic lapse rate. The change in air temperature with altitude. In well-mixed air the dry adiabatic lapse rate is 5.4° F. per 1,000 feet (0.98° c. per 100 m).

Aerosol. Particles suspended in air.

Aesthetics. The philosophy concerned with the perception of beauty. Visual perception of the beauty of landscapes involves the viewer's ideas, sensations, and feelings about what he sees, as well as the physical elements that comprise the view.

Agglomerate. To fuse into a mass.

AGL. (Above ground level), a height measured in feet or meters above the ground.

Alkaline soil. Precisely, any soil horizon having a pH value greater than 7.0; practically, a soil having a pH above 7.3.

Alkali soil. 1: A soil with a high degree of alkalinity (pH of 8.5 or higher) or with a high exchangeable sodium content (15 percent or more of the exchange capacity) or both. 2: A soil that contains sufficient alkali (sodium) to interfere with the growth of most crop plants.

Alluvial soils. An azonal great soil group developed from transported and relatively recently deposited material (alluvium) characterized by a weak modification (or none) of the original material by soil-forming processes.

Alluvium. Clay, silt, sand, and gravel or other rock material transported by flowing water and deposited as sorted or semi-sorted sediments.

Ambient air. Surrounding or circulating air.

Ambient air quality standard. A concentration of an air pollutant in the air for a specified time period designated to be the allowable maximum to protect public health (primary) or welfare (secondary).

Ammonium nitrite fuel-oil prill. A globular, porous particle obtained by spraying ammonium nitrate and fuel oil in a rising current of warm air. Used in blasting.

Angle of repose. Angle between the horizontal and the maximum slope that a soil assumes through natural processes.

Animal unit month. A measure of forage or feed requirement to maintain one animal (cow or five sheep) for a period of 30 days. Abbreviated: AUM.

Annual plant. A plant that completes its life cycle and dies in one year or less.

Anticline. Strata which dip in opposite directions from a common ridge or axis, like the roof of a house. A fold where beds are arched so as to incline away from each other.

Aquifer. A layer of rock, sand, or gravel that contains water and that will deliver it in usable quantities to wells.

Aquatic. Pertaining to or living in water.

Aquifer skeleton. The mineral framework of a water-bearing zone or aquifer.

Archaeological excavation. The scientifically controlled recovery or salvage of a site designed to yield maximum information about the life of the inhabitants, their ways of solving human problems, and of adjusting to and modifying their natural environment.

Archaeological inventory. A presentation and summation of the data presently known concerning an area.

Archaeological resources. Objects and areas made or modified by man and the data associated with these artifacts and features. These resources rest in or on the ground.

Artifact. A material object made or modified in whole or in part by man. Among the most common artifacts on archaeological sites are fragments of broken pottery (sherds), and stone tools, chips, projectille points, and similar lithic debris.

Ash. Noncombustible mineral matter contained in coal. These minerals are generally similar to ordinary sand, silt, and clay in chemical and physical properties.

Atmospheric stability. A measure of the extent to which vertical and horizontal mixing will take place. Commonly measured as unstable, neutral or stable.

Available water-holding capacity (soils). The capacity to store water available for use by plants, usually expressed in linear depths of water per unit depth of soil.

Back country. Areas which are essentially roadless. Effects of man may be present but are inconspicuous or unobtrusive.

Background air quality. The quality of air without significant local sources of man-made air pollution.

Biomass. Living mass per unit area per unit time.

Blowdown. Water drawn from cold water basins of cooling towers to prevent buildup of solid concentrates. Usually contains chemicals used for pH adjustment and slime control.

Botanical site. An area where there are plant or plant communities which have a special human interest value.

Btu. An abbreviation for British thermal unit, usually considered to be that amount of heat needed to raise the temperature of one pound of water from 63° F. to 64° F.

Calcareous soil. A soil that contains enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibility when treated with cold, dilute hydrochloric acid.

Slightly calcareous	1 to 3 percent lime
Moderately calcareous	3 to 15 percent lime
Strongly calcareous	15 to 40 percent lime
Very strongly calcareous	more than 40 percent lime

Chaining. The removal of the pinyon-juniper or sage brush vegetative type by dragging a large anchor chain over the area and pulling the trees over.

Class. A group of plants or animals ranking above an order and below a division (phylum).

Clay. As a soil separate, the mineral soil particles are less than 0.002 millimeters in diameter. As a soil textural class, the soil material is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Coal measures. Formations containing coal beds.

Colluvial, colluvium. Loose and incoherent deposits consisting of alluvium and angular fragments of rocks usually at the foot of a slope or cliff and brought there by gravity.

Community. An assemblage of organisms living together and interacting with each other in a characteristic natural habitat.

Coning plume. Effluent plume, shaped like a cone with a horizontal axis, usually occurring in a neutral atmosphere with wind velocity greater than 20 mph.

Corridor. A corridor is a strip of land of undefined width that, based on ecological, technical, and economic factors, is more suited for utility rights-of-way than adjacent lands.

Cover. Shelter needed or available for animals.

Crucial habitat. That part of the natural environment of an animal, which if lost, would lead to the animals demise.

Cultural values. Value of places, objects, and structures that are important to the present day activities of subcultures existing in this country. Such areas are important and have value, not because of public educational or historic interests, but because they are vital to the preservation of a subculture.

Cyclonic storms. Large storm systems (50 to 900 miles in diameter or more) characterized by air rotating around a center of low pressure. More common in winter than summer. Rainfall and snowfall associated with such storms may be light, but may persist for two to three days or longer.

Decomposers. Primarily bacteria and fungi which ingest food by absorption.

Deposition. The set of physical processes that transfer a substance from the atmosphere to the Earth's surface.

Depth, soil. The thickness (in inches) of soil that plant roots can readily penetrate to obtain water and nutrients. Deep soils are more than 40 inches; moderately deep soils are 20 to 40 inches; shallow soils are 10 to 20 inches; and very shallow soils are less than 10 inches.

Dew point. The temperature to which air must be cooled in order for saturation to occur.

Diffuse solar radiation. Radiation from the sun reaching an observation point indirectly by scattering in the atmosphere.

Direct solar radiation. Radiation from the direct rays of the sun reaching an observation point.

Dispersion. The physical process of diluting the concentration of a substance in a fluid by molecular and turbulent motion; e.g., smoke in air.

Dissolved solids. The dissolved chemical constituents in water; concentration is commonly expressed in milligrams per liter (mg/l).

Diurnal. Showing a periodic alteration of condition with day and night.

Drainage, natural soil. This term refers to the conditions of frequency and duration of periods of saturations or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized:

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the A and B horizons. They have uniformity of color in the A and upper B horizons and have mottling in the lower B and C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time. For example, Podzolic soils commonly have mottlings below a depth of six to sixteen inches, in the lower A horizon, and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be minimal or absent in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Dry adiabatic lapse rate. Decrease in temperature with height at a rate of 1 deg Centigrade per 100 m.

Ecosystem. A system formed by the interrelationship of the living and non-living things within their environment.

Emission standard. Limitations to the permissable discharge into the atmosphere of pollutants such as particulates, sulfur oxides and nitrogen oxides.

Endangered species. Those species in danger of extinction throughout all or a significant portion of their range.

Entrainment. A process of transferring by turbulence a substance into a moving fluid; in this case, the transfer of dust and sand into the atmosphere by wind.

Environment. The total of conditions surrounding an entire organism.

Epidemicological. Affecting at the same time a large number of persons in a locality.

Erosion. The wearing away of the land surface by wind (sandblast), running water, gravity and other geological agents.

Erosion pavement. The small surface gravel which is left on the land after the soil is eroded away.

Eutrophication. The aging process of lakes and bays whereby depths of the bodies of water become shallower due to the deposition of sediment and vegetation. Such bodies of water have a greater primary food production, but summer stagnation may be severe enough to exclude cold-water fishes.

Fanning plume. Effluent plume with very little vertical spread but a meandering trajectory in the horizontal plane. Characteristic of a plume emitted under extreme inversion conditions.

Fault. A fracture or fracture zone along which there has been displacement of the two sides relative to one another, parallel to this fracture plain.

Fauna. All the animal life in a given region or period of time.

Flood plain. A nearly level land surface consisting of stream sediments that borders a water course and is subject to flooding unless protected artificially.

Flora. All the plant life in a given region or a period of time.

Fly ash. The solid particles that are carried out of a combustion furnace in the exhaust gas flow.

Food chain. A group of plants and animals linked together by their food relationships.

Fumigation. Rapid mixing of a fanning plume down to the ground, such as during inversion breakup.

Game species. Wildlife species which are hunted or pursued.

General leisure. Activities which support the participation in, or involve the observation of, other activities. Includes camping, picnicking, and other similar recreation pursuits.

Geologic site. Any unusual or attractive geological phenomenon with special human interest value.

Gradient wind level. Upper limit of frictional influence of the earth's surface, usually between one and two km.

Gypsum soils. Soils which contain high amounts of hydrated calcium sulfate ($CaSO4, 2H2O$), occurring in crystals and in masses. Calcium sulfate is water soluble and will dissolve out of the soil profile when exposed to high amounts of water, which in turn creates a piping affect (a downward or lateral movement of water through the soil).

Habitat. The natural environment of a plant or animal. The place where they are usually found.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material may be gravelly, sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substances.

Heavy Metals. Metallic elements generally occurring in trace amounts in water; including iron, manganese, copper, aluminum, zinc, cadmium, chromium, lead, arsenic, mercury, and vanadium.

Herbivores. Animals which feed upon plants exclusively.

Historic site. Any place associated with a significant event, an important person, or a cultural activity of the past. Historic in most cases is 50 years old or older, except for rare instances where exceptional events have taken place such as the site of the first atom bomb detonation.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

These are the major horizons:

O horizon - The layer of organic matter on the surface of a mineral soil, consisting of decaying plant residues.

A horizon - The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon - The mineral horizon just below an A horizon. The B horizon is in part a layer of change from the overlaying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum.

C horizon - The weathered rock material immediately beneath the solum. In most soils, this material is presumed to be like that from which the overlying horizons were formed.

R layer - Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Hunting. Lawful attempts to take game animals.

Incised. Cut down into, as a river cuts into a plateau.

Insolation. Solar radiation received at the earth's surface.

Intensive archaeological reconnaissance. An on-the-ground surface survey and testing of an area sufficient to permit determination of the number and extent of the resources present, their scientific importance, and the time factors and cost of preserving them or otherwise mitigating any adverse affects on them.

Inversion. A change of temperature with height greater than $-1^{o}C/100m$. therefore no change with height (isothermal) or an increase with height would be classified as an inversion.

Isopleths. Line of equal or constant value of a given quantity with respect to space or time.

Isothermal. No temperature change with height.

Lapse rate. The change of temperature with height. A "lapse" condition usually means a decrease with height.

Lime. Lime is calcium oxide (CaO), but its meaning has been extended to include all limestone-derived materials applied to neutralize acid soils. Agricultural lime can be obtained as ground limestone, hydrated lime, or burned lime, with or without magnesium minerals. Basic slag, oystershells, and marl also contain calcium.

Lithic Calciorthids . Soils that have had much lime in the parent material or added in dust. Low rainfall is unable to remove the lime completely from the surface soil to a depth of 7 inches unless the texture is sandy. Most of these soils are calcareous in all horizons and have a rock layer within 20 inches of the soil surface.

Lithic Ustic Torriorthents. Soils with a recent erosional surface, receiving most of their moisture during the summer months, the soil temperature at the depth of 20 inches is 41° F or higher and has a rock layer within 20 inches of the soil surface.

Lithic Ustollic Calciorthids. These soils have the same characteristics as the Lithic Calciorthids but are dry three-fourths of the year, receive moisture during the summer months and have a mean annual soil temperature of 47° F or higher.

Looping plume. Effluent plume being rapidly spread upward and downward by thermally induced eddies. Occurs in a highly unstable atmosphere because of rapid mixing.

Megawatt. One million watts, a unit of power or energy per unit time.

Micron. (u) One millionth of a meter, more properly called a micrometer (um).

Millibar. Pressure unit of 1,000 dynes per square cm.

Mixing height. Height of the layer of air where well-mixed conditions exist, usually the height of the first significant inversion above the surface.

Monocline. Beds inclined in a single direction.

Mottled. A description for soils irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms and their meaning include abundance: few, common, and many; size: fine, medium, and coarse; and contact: faint, distinct, and prominent. The size measurements include: fine, less than five millimeters (about 0.2 inch) in diameter along the greatest dimension; medium, ranging from five millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and coarse, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

MSL. (Mean sea level) The height measured in feet or meters above sea level.

National register of historic places. A listing maintained by the National Park Service of architectural, historical, archaeological, and cultural sites of local state, or national significance.

Nephelometer. General name for instruments which measure, at more than one angle, the scattering function of particles suspended in a medium.

Neutral atmosphere. A condition characterized by an existing dry adiabatic temperature lapse rate.

Non-game species. Wildlife not classified as game species, and not typically pursued by hunters.

Nonspecular. Not shiny.

Off-road vehicle. Any vehicle (including the standard automobile) designed for, or capable of, travel on or immediately over land, water, sand, snow, ice, marsh, swampland, or other natural terrain. It includes, but is not limited to: four-wheel drive or low-pressure tire vehicles, motorcycles and related two-wheel drives, snowmobiles, amphibious machines, ground-effect or air-cushion vehicles, recreation vehicle campers, and any other means of transportation deriving motive power from any source other than muscle, except that such terms exclude motorboats.

Opacity. The degree to which emissions reduce the transmission of light and obscure the view of an object in the background.

Oxidant. A gas that oxidizes; usually ozone.

Parent material. The disintegrated and partly weathered rock from which soil is formed.

Particulate. Minute particles of coal dust, fly ash, and oxides temporarily suspended in the atmosphere.

Perennial. (Plants) A woody or herbaceous plant living from year to year, not dying after once flowering.

Perennial. (Streamflow) Streams that flow throughout the year from source to mouth.

Permeability. The quality of a soil horizon which enables water or air to move through it. Terms and rates in inches per hour used to describe permeability are as follows: very slow - less than 0.06, slow - 0.06 to 0.2, moderately slow - 0.2 to 0.6, moderate - 0.6 to 2.0, moderately rapid - 2.0 to 6.0, rapid - 6.0 to 20.0, and very rapid - more than 20.0.

pH. A number that represents the negative logarithm, base 10, of the hydrogen-ion activity of a solution. A pH less than 7 indicates an acid solution; a pH greater than 7, an alkaline solution.

Photochemical. Referring to chemical reactions that require light.

Photometry. A physical method of measurement based on the transmission of light.

Picknicking. Day use activities related to an excursion or outing where food is usually provided and consumed at a recreation site (developed or undeveloped).

Picocurie. One trillionth (million millionth or 10^{-12}) of a curie, a measure of radioactivity.

Pilot balloon. Small balloon with known ascent rate whose track is followed by a theodolite (optical tracking instrument similar to a surveyor's transit) in order to obtain data for the computation of speed and direction of winds in the upper air.

Plume. A large conspicuous cloud of smoke, dust, or water vapor arising from a stack.

Precipitator (electrostatic). Device employing principles of electromagnetic removal of particles from air.

Preliminary archaeological reconnaissance. An on-the-ground surface examination of selected portions of an area adequate to assess the general nature of the archaeological resources probably present.

Primitive areas. Natural, wild, and undeveloped areas essentially removed from the effects of civilization.

Profile, soil. A vertical section of the soil through all it's horizons and extending into the parent material.

Protected. An animal which may not be taken in any manner.

Radiational cooling. Cooling of the earth's surface and adjacent air accomplished mainly at night whenever the earth's surface suffers a net heat loss.

Radiation inversion. Increase of temperature with height starting at the surface of the earth and due to radiational cooling.

Rainout. Particulate or gaseous matter removal from the atmosphere due to association of the matter with the precipitation element before its descent.

Raptors. Birds which prey on other animals; birds of prey.

Rare. A rare species is one that although not presently threatened with extinction is in such small numbers throughout its range that it may be endangered if its environment is adversely affected.

Rawinsonde. Method of upper-air observation consisting of a computation of wind speed and direction, temperature, pressure and relative humidity by means of a balloon-borne radiosonde tracked by radar.

Relative humidity. Ratio of the actual vapor pressure of the air to the saturation vapor pressure.

Riparian. Vegetation and/or animals dwelling along a perennial stream, or body of water.

Rockiness. A description of rock expressed as a volume percentage of the surface. General classifications are:
Class 0 - less than 2 percent, Class I - 2 to 10 percent (rocky), Class II - 10 to 25 percent (very rocky), Class III - 25 to 50 percent (extremely rocky), Class IV - 50 to 90 percent (rockland) and Class V - over 90 percent (rock outcrop).

Runoff. Refers to the rate water moves by flow over the surface of the soil. Rates are slow, medium, and rapid.

Sand. As a soil separate, the individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. As a soil textural class, soil material that is 85 percent or more sand and not more than 10 percent clay.

Scrubber. An apparatus designed to remove impurities from gases.

Sediment yield. The amount of soil an area loses every year through natural processes, usually expressed in acre-feet per square mile per year. One acre-foot per square mile per year, reduced to simpler terms, means that a square mile of land loses about .01 inches of soil every year. This is a result of the normal and ongoing processes of water and wind erosion.

Shrink-swell. Describes that soil quality that determines its volume change with change in moisture content.

Silt. As a soil separate, the individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil material that is 80 percent or more silt and less than 12 percent clay.

Skeletal. Soils that are very poorly developed and exhibit little or no horizonal development in the soil profile.

Slurry. A mixture of water and powdered coal, commonly in roughly equal proportions by weight.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. Describes the combined A and B horizons of the soil profile. If the soil lacks a B horizon, then the A horizon is the solum.

Stable atmosphere. A condition characterized by a temperature change with height greater than $-1^{\circ}C/100$ m (see inversion).

Status, undetermined. A species or subspecies which has been suggested as possibly threatened with extinction, but about which there is not enough information to determine its status.

Stones. Rock fragments greater than 10 inches in diameter, if rounded, and greater than 15 inches along the longer axis, if flat.

Stoniness. Fragments of rock particles over 10 inches in diameter expressed as a volume percentage of the surface. Class 0 - no stone, Class I - from none to 0.1 percent, class II - 0.1 to 3 percent, class III - 3 to 15 percent, class IV - 15 to 90 percent and class V - over 90 percent.

Stratigraphy. That branch of geology which treats of the formation, composition, sequence, and correlation of the stratified rocks as parts of the earth's crust.

Subsidence inversion. Air inversion aloft caused by sinking air within a high pressure system which causes the temperature at the top of the layer to increase more than the temperature at the bottom of the layer. The effect is the creation of a limited mixing volume below the stable layer.

Subsoil. Describes the B horizon of the soil profile roughly, the part of the solum below plow depth.

Substratum. Describes the part of the soil below the solum.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon and part of B horizon and has no depth limit.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about five to eight inches in thickness. The plowed layer.

Susceptibility to erosion. This could be a confusing term because most soils generally are stable in their natural condition. However, when a soil is disturbed, it can become susceptible to erosion to either a slight, moderate, or severe degree.

Syncline. A fold in rocks in which the strata dip inward from both sides toward the axis. The opposite of anticline.

Synergistic. Cooperative action of discrete agencies such that the total effect is greater than the sum of the two effects taken independently.

Synoptic pressure pattern. Pattern of isopleths (see glossary definition) of constant pressure over a horizontal surface (usually mean sea level) at a given time. Can also mean isopleths of height of a given pressure at a given time.

Techtonic. Of, pertaining to, or designating the rock structure and external forms resulting from the deformation of the earth's crust. As applied to earthquake, it is used to describe shocks not due to volcanic action or to collapse of caverns or landslides.

Terrestrial. Belonging to or living on the ground or earth.

Texture, soil. Describes relative proportions of sand, silt and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles are sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay and clay. Coarse, fine and very fine may be used to modify the basic textural class.

Threatened Species. Those species which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Turbidity. A measure along the line of sight of the attenuation of solar radiation in a clear sky due to atmospheric suspensoids.

Typic alciorthids. These soils have a high content of lime in the parent material or added in dust. The low rainfall is unable to remove the lime completely from the surface soil to a depth of seven inches unless the texture is sandy. Most of these soils are calcareous in all horizons. These soils are not saturated with water for 90 consecutive days or more in most years within 40 inches of the surface. There is no rock layer within 20 inches of the soil surface. The soil temperature is 41^{o} F. or higher at a depth of 20 inches.

Typic Haploborolls. These soils are mostly cool, but not cold, and are found in late Pleistocene or Halocene deposits or on land surfaces of those ages. The soil textures in the upper 30 inches are coarser than loamy, fine sand. There is also a regular decrease in organic content with increasing depth. There is no rock layer within 20 inches of the soil surface.

Typic Torriorthents. These soils have a mean annual temperature of 48° F. and receive six inches of rainfall a year. There are no horizons within 40 inches of the soil surface that are greater than six inches thick. The soil profile is not saturated with water within 60 inches of the soil surface at any time of the year in most years. There is no rock layer within 20 inches of the soil surface.

Typic Torripsamments. These soils consist of sands receiving six inches of rainfall a year which then are formed into either moving or stabilized dunes. These sand deposits are of late Pleistocene age or younger. There are no horizons within 40 inches of the soil surface that are greater than six inches thick. These soils are dry three quarters of the time and have a mean annual soil temperature of 41° F. There is no rock layer within 20 inches of the soil surface.

Typic Ustorthents. These soils are deep to moderately deep over hard rock and have no clayey texture and a swelling type clay. There is no horizon within 40 inches of the soil surface that is six inches thick. The soil profile is not saturated with water within 60 inches of the soil surface for as long as one month in most years. There is no rock layer within 20 inches of the soil surface.

Unstable atmosphere. A condition characterized by a temperature decrease with height greater than the standard adiabatic lapse rate of $1^{o}/100$ m. Marked vertical mixing occurs and pollutants are rapidly dispersed.

Ustic Torrifluvents. These soils are formed from recent water-deposited sediments and are not flooded frequently or for long periods of time. There are no horizons within 40 inches of the soil surface that are greater than six inches thick. These soils are also either alkaline or calcareous. They are dry three quarters of the time, receive moisture during the summer months and have a soil temperature of 41° F. at the 20 inch depth.

Ustic Torriorthents. These soils have a mean annual temperature of 48° F. and receive six inches of rainfall a year. There are no horizons within 40 inches of the soil surface that are greater than six inches thick. The majority of the moisture occurs during the summer months. The soil profile is not saturated with water within 60 inches of the soil surface at any time of the year in most years.

Ustic Torriorthents (shallow). These soils are the same as the Ustic Torriorthents but are only 10 to 20 inches deep.

Ustollic Calciorthids. These soils differ from the Typic Calciorthids in that they have more organic matter and more moisture. They receive most of their moisture during the summer months.

Ustollic Camborthids. These soils have a subsoil horizon whose texture is finer than loamy, fine, sand in which the materials have been altered or removed. The mean annual temperature is 48° F. or higher. These soils contain higher than normal amounts of organic matter and moisture. However, they are not saturated for 90 consecutive days or more in the upper 40 inches of the profile in most years. There are no horizons within 40 inches of the soil surface that are greater than six inches thick.

Ustollic Haplargids. These soils contain high amounts of organic matter and receive the majority of their moisture during the summer months. There is an accumulation of silicate clays in the B horizon of the soil profile, usually within 20 inches of the soil surface. The texture is finer than loamy, fine, sand above a depth of 20 inches. The soil is not saturated with water for 90 days in most years. There are no horizons within 40 inches of the soil surface that are greater than six inches thick. There is no rock layer within 20 inches of the soil surface.

Visibility. The greatest distance in a given direction at which it is possible to see and identify with the unaided eye a prominent dark object against the sky at the horizon.

Washout. Particulate or gaseous matter removal from the atmosphere due to association of the matter with precipitation elements during their descent.

Wet cooling tower system. This system utilizes evaporation of some of the condenser cooling water to cool the remainder and discharges the heat of evaporation into the atmosphere.

BIBLIOGRAPHY

CHAPTER I

Bechtel Power Corporation, The Kaiparowits Project -- geology, coal quality and reserves (final study report), Bechtel Power Corporation, Norwalk, California, 1973.

Doelling, H. H. and Graham, R. L., Southwest Utah Coalfields, Monograph Series No. 1, Utah Geological and Mineral Survey, Salt Lake City, 1972.

Palowitch, E. R. and Briskey, P. J., "Designing the Hendrix Number 22 Shortwall," *Mining Congress Journal*, June, 1973.

BIBLIOGRAPHY

CHAPTER II

Abbey, Edward and Philip Hyde, Slickrock, Endangered Canyons of the Southwest, Sierra Club/Charles Scribner's Sons, New York 1971.

Albright, George Leslie, Official Explorations for Pacific Railroads 1853-1855. University of California Press, Berkeley, 1921.

Allred, D. M., Navajo Generation Station Ecological Baseline Study, Annual Report 6/1/71-6/1/72, BYU Press, Provo, Utah, 1972.

Akers, J. P., M.E. Cooley and P.E. Dennis, Synopsis of Ground Water Conditions on the San Francisco Plateau near Flagstaff, Coconino County, Arizona, USGS Open File Report, 1964.

Anderson, Orson L. and Priscilla C. Perkins, "Some Consequences of Restricting the Maximum Elevation of Lake Powell," Lake Powell Research Project, Progress Report No. 3, Institute of Geophysics and Planetary Physics, U.C.L.A., July 1973.

Arizona Bureau of Mines, Geologic Maps for Coconino, Mohave, and Yavapai Counties, Arizona; Arizona Bureau of Mines, 1968.

__________, "Mineral and Water Resources of Arizona," Arizona Bureau of Mines Bulletin 180, Arizona Bureau of Mines, Tucson, Arizona, 1960.

Arizona Dept. of Economic Planning and Development, Demographic and Economic Projections for the State of Arizona and its Counties to the Year 2000 Using the Arizona Trade-off Model, 1970.

__________, Planning and Development Districts and Socio-economic Projections for the State of Arizona, 1970.

__________, Preliminary Economic Base Analysis of Arizona's Counties, Economic Research Working Paper Series No. 70-3, July 1970.

Arizona Resources Information System, The Natural Vegetation of Arizona, 1973.

Arizona State Department of Health, Water Quality Report, Engineering Bull. No. 13, 1962.

Arizona State University, The Glen Canyon Project--A Study and Recommendation Regarding the Community of Page, Arizona, Tempe, Arizona, December 20, 1967.

Arrington, Leonard J., Great Basin Kingdom, University of Nebraska Press, Lincoln, Nebraska, 1958.

Axelrod, D. I. Studies in Late Tertiary Paleobotany, Publication #590, Carnegie Institution, Washington, D. C., 1950.

Bagley, J.M., Jeppson, R.W. and Milligan, C.H., Water Yields in Utah, Agricultural Experiment Station Special Report 18, Utah State University, 1964.

Balda, Russell P. and Clarence D. Johnson, Northern Arizona University, Biology Department, unpublished data, 1974.

Barker, James P., "Preliminary Report on Field Survey and Site Record Search: Southern California Edison Proposed Kaiparowits Transmission Line," Ms. Archaeological Research Unit, Dry Lands Research Institute, University of California, Riverside, 1974.

_________, and Sarah H. Schlanger, "An Archaeological Survey of Segments D and E of the Proposed Kaiparowits Transmission Line Route." Ms. Archaeological Research Unit, Dry Lands Research Institute, University of California, Riverside, 1974.

Barnes, C. T., The Cougar or Mountain Lion, The Ralton Company, Salt Lake City, Utah, 1960, pp. 71-85.

________, Utah Mammals, Volume 17, No. 12, The University of Utah, June, 1927.

Barrett, R. H., Seasonal Food Habits of Bighorn at the Desert Game Range, Nevada Desert Bighorn Council Trans., 1964, 8:85-93.

Beal, L. H., Geology and Mineral Deposits of the Bunkerville Mining District, Clark County, Nevada, Nevada Bureau of Mines, Bull. 63, 1965.

Beale, D. M., The Relationship of Range Conditions to Pronghorn Antelope Productivity and Survival, Utah State Dept. of Fish and Game, Fed. Aid Job Completion Rep., Proj. No. W-105-R-2, 1966.

________, and G. W. Scotter, "Seasonal Forage Use by Pronghorn Antelope in Western Utah," Utah Science, Agricultural Experiment Station, Logan, Utah, 1968, 29:1.

Bean, Lowell,and Harry Lawton, "The Cahuilla Indians of Southern California," Malki Museum Brochure No. 1, Banning, 1965.

Beard, L.R., Statistical Methods in Hydrology, U. S. Army Corps of Engineers Dist., Sacramento, California: 1962.

Bent, A. C. Life Histories of North American Birds of Prey. Dover Publ. Inc., N.Y. Rep. 1937. 1961a, Part No. 1.

_________, Life Histories of North American Birds of Prey, Dover Publ.Inc., N.Y. Rep. 1937. 1961b, Part II.

_________, Life Histories of North American Gallinaceous Birds, Dover Publ. Inc., N.Y. Rep. 1932, 1963, p. 40-43.

Bettinger, Robert and R.E. Taylor, "Suggested Revisions in Interior Southern California Archaeological Sequences," Nevada State Museum Papers, Carson City, 1974.

Blim, D., Stewart, A., and Wilkes, S., The Limnology of Wahweap and Warm Creek Bays of Lake Powell, Environmental Studies of the Navajo and Kaiparowits Power Plants, 2nd Annual Report, Northern Arizona University Flagstaff, Arizona, 1973.

Bond, F.M., "Falcons" Symposium on Rare and Endangered Wildlife of the Southwestern United States. New Mexico Fish and Game Dept., 1972, pp. 51-55.

Breed, William and Barton Wright, The Age of Dinosaurs in Northern Arizona, Museum of Northern Arizona, Flagstaff, Arizona, 1968.

Bres, Harold, Personal Communications. Mr. Bres is employed by Clark County, Nevada Health Department, Air Quality Control, 1975.

Briggs, G. A.,"Plume rise," USAEC Report TID-150 75. Available from Clearinghouse for Federal Scientific and Technical Information. National Bureau of Standards. U.S. Dept. of Commerce, Springfield, Virginia 22151, 1969.

Brigham Young University, A Study to Identify Potentially Feasible Small Businesses for the Navajo Nation, January 1975, Vols. I, II, & III.

__________, Environmental Studies of the Navajo and Kaiparowits Generating Stations, Annual Report 1972.

__________, Kaiparowits Project Environmental Report, June 1973, Vol. 2.

Brooks, Richard H., Daniel O. Larson, and Michael Compton, "An Archaeological Report on a Preliminary Reconnaissance of the Proposed Eldorado/Kaiparowits Transmission Line Right-of-Way Corridor," Ms. Nevada Archaeological Survey, University of Nevada, Las Vegas, 1974.

__________, Daniel O. Larson and Joseph King, "A Limited Archaeological Survey of Three Alternate Routes in Clark County, Nevada," Ms. Nevada Archaeological Survey, University of Nevada, Las Vegas, 1975.

Buechner, H. K., The Bighorn Sheep in the United States, Its Past, Present and Future, Wildlife Society, Wildlife Mono. No. 4, 1960.

Bullen, K.E., An Introduction of the Theory of Seismology, Cambridge University Press, Cambridge, Mass., 1963.

Bureau of Economics and Business Research, Utah Facts, Center for Economic and Community Development, University of Utah, 1973.

Cahalane, V.H. Cougar, Grizzly, and Wolf in North America, N. Y. Zool. Soc., 1964.

Cain, D., The Ely Chain, Bureau of Land Management, Ely, Nev., 1971.

Campbell, E.W.C., and W.H. Campbell, "The Pinto Basin Site" Southwest Museum Papers No. 9, Los Angeles, 1935.

__________, et al., "The Archaeology of Pleistocene Lake Mohave," Southwest Museum Papers, No. 11, Los Angeles, 1937.

California Department of Fish and Game, At the Crossroads 1974, A Report on California's Endangered and Rare Fish and Wildlife, 1974.

California Division of Mines, Geologic Map of California; California Division of Mines, Sacramento, California, Kingman Sheet, 1961; Needles Sheet, 1964; Salton Sea Sheet, 1967; San Bernardino Sheet, 1967, and Santa Ana Sheet, 1966.

__________, "Geology of Southern California," Calif. Division of Mines Bulletin 170, Calif. Division of Mines, Sacramento, California, 1954.

California Native Plant Society, Inventory of Rare, Endangered, and Extinct Vascular Plants of California, 1972.

California Region, State - Federal Interagency Group, California Region Comprehensive Framework Study, Pacific Southwest Interagency Committee, 1971, Appendices V, X, XI, XV.

Carpenter, C.H., Robinson, G.B., Jr., and Bjorklund, L.J., Ground Water Conditions and Geologic Reconnaissance in the Upper Sevier River Basin, Utah, U.S. Geological Survey Water Supply Paper 1836, U.S. Geological Survey, Washington, D.C., 1967, p. 55.

Center of Social Research and Development, University of Denver, Socio-economic Data Rank Ordered for Utah, Denver, Colorado, 1973.

Chaloupka, Chris, "Archaeological Survey of Martinez Canyon," Ms. Department of Anthropology, University of California, Riverside, 1972.

Clark County Regional Planning Council, Parks and Open Space Plan, 1971.

Cleveland, N.F., Impact Survey Study for Power Transmission Line (Devers-Serrano), U.S. Department of Agriculture, 1970.

Coffman, J.L. and Vone Hake, Carl A. (Editors), "Earthquake History of the U.S.," Natl. Oceanic and Atmospheric Administration Pub. 41-1, U.S. Department of Commerce, Washington, D.C., 1973.

____________, United States Earthquakes, 1970, U.S. Dept. of Commerce, NOAA, Bull. 1-TS6937, 1972.

Cook, K.L. and R.B. Smith, Seismicity in Utah, 1850 through June 1965. Bull. Seism. Society of American, Vol. 57, August 1967.

Cooke, R.V. and A. Warren, Geomorphology in Deserts, University of California Press, 1973.

Coombs, E.M., "Desert Tortoise, Gopherus agassizi, Study Progress Report, Summer 1973 in the Beaver Dam Wash Area," Bureau of Land Management, Cedar City, Utah, 1973.

Cornwall, H.R., Geology and Mineral Deposits of Southern Nye County, Nevada, Nevada Bureau of Mines, Bull. 77, 1972.

Corps of Engineers, Flood Plain Information - Lower Las Vegas Wash, Clark County, Nevada, 1967.

Crampton, C. Gregory, "Historical Sites in Glen Canyon, Mouth of San Juan River to Lees Ferry," Anthropological Papers, No. 46, University of Utah, Salt Lake City, 1960.

______, Land of Living Rock, Alfred A. Knopf, Inc., New York, 1972.

Crawford, John E., and Larry A. Dunkeson, Powerline Standards to Reduce Raptor Losses on the National Resource Lands, paper presented at Conference on Raptor Conservation Techniques, March 22-24, 1973, Fort Collins, Colorado, 1973.

Cruff, R. W. and Thompson, T. H., "A Comparison of Methods of Estimating Potential Evapotranspiration from Climatological Data in Arid and Sub-humid Environment," U.S. Geological Survey Water Supply, 1967, p. 1839M.

Dames and Moore, Air Quality Monitoring Study, Navajo Generation Station. Status Report, June 1971.

________, "Meteorological Evaluation of the Nipple Bench Area, Kaiparowits Plant Site." Appendix D. Kaiparowits Project Environmental Report, June 1973.

________, Air Quality Monitoring and Meteorology, Navajo Generating Station, 1973. Report to Bechtel Power Corporation March 29, 1974.a

________, Climatological Data Summary, Nipple Bench, Kane County, Utah. Report to Southern California Edison February 18, 1974.b

_________, for Bechtel Corporation, Meteorological Data Summaries (October 1971-December 1972), Nipple Bench Plant Site, Kaiparowits Project.

Dasmann, R. F., "Biomass, Yield and Economics Value of Wild and Domestic Ungulates," Proc. Union Inter. Game Biologist, Bournemouth, England, 1964.

Dasmann, W., If Deer are to Survive, Wildl. Management Inst., Stackpole Books, Harrisburg, Penna., 1971.

Daubenmire, R., Plant Communities, A Textbook of Plant Synecology, Harper & Row Publishers, New York, 1968.

Davidson, E. S., Water Resources Appraisal of the Big Sandy Area, Mohave County, Arizona, Arizona Water Commission, Bull. No. 6, 1973.

Davis, Jerry W., Unpublished Checklists of the Birds and Mammals of the Kaibab National Forest, U.S. Dept. of Agriculture, Forest Service, 1974.

DeCalesta, D. S., A Literature Review of Cottontail Feeding Habits, Spec. Rep. No. 25, Colorado Division of Game, Fish and Parks, Denver, Colorado, 1971.

Dibblee, T. W., Jr., "Geology of the Imperial Valley Region, California," California Division of Mines and Geology Bulletin 170, Sacramento, 1954.

Doelling, H. H. and R. L. Graham, Southwest Utah Coalfields, Utah Geological and Mineralogical Survey, Monograph Series No. 1, 1972.

Dregne, Harold E., "Surface Materials of Desert Environments," Deserts of the World, William G. McGinnies, Bram J. Goldman, Patricia Paylore (Editors), University of Arizona Press, Tucson, Arizona, 1968.

Drewien, G., Food Habits and Weight Relationships of Mourning Doves in Northern Nevada, M.S. Thesis, University of Nevada, 1971.

Duffy, Jean, "Page, Arizona: The Town a Dam Built," Arizona Highways, January 1964, Vol. XL, No. 1, P.3.

Dunaway, D. J., Human Disturbance as a Limiting Factor of Sierra Nevada Bighorn Sheep, First North American Wild Sheep Conference, Colorado State University, Fort Collins, Colorado, April 14-15, 1971.

Durrant, Stephen D., Mammals of Utah, University of Kansas, Lawrence, 1952.

Eakin, Thomas, Ground-Water Resources - Reconnaissance Series Report 25, State of Nevada Dept. of Conservation and Natural Resources, February 1964.

Ecker-Racz, L. L., The Politics and Economics of State-Local Finance, Prentice-Hall, Englewood Cliffs, New Jersey, 1970.

EDAW Inc., Kaiparowits Transmission System - Land Use Visual Conditions Socio economic Analysis, August 1974.

Edminster, F. C., American Game Birds of Field and Forest, Castle Books, New York, N.Y., 1954.

Einarsen, A. S., The Pronghorn Antelope and its Management, Wildl. Manage. Inst., Washington, D. C., 1948, p. 134-135.

Eisenbud, M., H.G. Petrow, "Radioactivity in the Atmospheric Effluents of Power Plants That Use Fossil Fuels." Science 1964, 144:288-289.

Ellis, David H., Dwight G. Smith and Joseph R. Murphy," Studies on Raptor Mortality in Western Utah," Great Basin Naturalist, 1969.

Engle, R., "Geology of the Lake Elsinore Quadrangle, California," California Division of Mines Bulletin, 146, Sacramento, 1959.

Environmental Impact Statements, Cholla, TG&E, Navajo Project, and Kaiparowits.

ESSA, Climatic Atlas of the United States, U. S. Department of Commerce, Environ mental Science Ser. Adm., Environmental Data Ser. 1968, p. 69, 70.

Fish, Paul R., "Draft Report: Archaeological, Ethnohistorical and Historical Consul tation for Proposed Kaiparowits Power Project Plant Sites, Transmission Lines, and Impact Study Area," Ms. Museum of Northern Arizona, Dept. of Anthropology, Flagstaff, 1974.

________, "Preliminary Report for Archaeological and Ethnohistorical Phase I Consultation for the Kaiparowits Power Project: Proposed Plant Sites, Impact Study Area, and Proposed Transmission Line Corridors." Ms. Museum of Northern Arizona, Department of Anthropology, Flagstaff, 1974.

Four Corners Regional Commission, Development Plan, U. S. Dept. of Commerce, February 1972.

Fowler, Don D. and Aikens, C. Melvin, "1961 Excavations, Kaiparowits Plateau," Anthropological Papers, No. 66, University of Utah, Salt Lake City, 1963.

Frick and Childs, Extinct Vertebrate Faunas of the Badlands of Bautista Creek and San Timateo Canyon, Sci. Bull., Vol. 12, University of California, Department of Geology, 1921.

Frome, M., The Varmints -- Our Unwanted Wildlife, Conard-McCann, 1969, pp. 36-49.

Geist, V., Mountain Sheep: A Study in Behavior and Evolution, The Univ. of Chicago Press, Chicago, Ill., 1971, p. 1-18, 347-353.

Gier, H. T. Coyotes in Kansas, Agric. Exp. Sta., Kansas State Univ., Manhattan, Kansas, 1968.

Gillespie, J.B. and C.B. Bentley, Geohydrology of Hualapai and Sacramento Valleys, Mohave County, Arizona, USGS Water Supply Paper 1899-H, 1971.

Glancy, Patrick and A.S. Van Denburgh, Water Resources - Reconnaissance Series Report 51, 1969.

Gloss, Steven P., Victor Starostka and Charles Thompson, Glen Canyon Reservoir Post Impoundment Investigations, Utah State Division of Wildlife Resources, 1971.

Golden, Robert E., Outdoor Recreation in Arizona, Phoenix Books, Phoenix, Arizona, 1973.

Gregory, Herbert E. and Raymond C. Moore, The Kaiparowits Region, A Geographic and Geologic Reconnaissance of Parts of Utah and Arizona: U.S. Geological Survey Professional Paper 164, 1931.

Gullion, G. W. and G. C. Christensen, "A Review of the Distribution of Gallinaceous Game Birds in Nevada," The Condor, Cooper Ornithological Society, Waterbury, Ohio, 1956, 59:128-138.

________, "Wildlife Uses of Nevada Plants," Paper No. 5140, Sci. J. Ser., Minn Agric. Exp. Sta., Univ. of Minn., St. Paul, Minn., 1964.

Hackman, Robert J. and Donald G. Wyant, Geology, Structure, and Uranium Deposits of the Escalante Quadrangle, Utah and Arizona: U. S. Geological Survey Miscellaneous Geologic Investigations Map I-744, 1973.

Hagen, R. H., (Chn.) and others, Water Quality Pollution and Health Factors (in the Upper Colorado Region), Appendix XV Upper Colorado Region Comprehensive Framework Study, Pacific Southwest Interagency Committee, 1971.

Hagihara, J.S., Rice, C.M., and Langan, L.N. Interim Guide for Rating Soils According to Their Soil Suitability for Rangeland Seeding. Technical Note. Portland Service Center, Bureau of Land Management, 1972.

Hahl, D. C. and Mundorff, J. C., An Appraisal of the Quality of Surface Water in the Sevier Lake Basin, Utah Department of Natural Resources Technical Publication 19, Utah Department of Natural Resources, Salt Lake City, Utah, 1968.

Hall, J. G., "The Kaibab Squirrel." Symposium on Rare and Endangered Wildlife on the Southwestern United States. New Mexico Dept. of Game and Fish, Sante Fe, New Mexico, 1972, pp. 18-21.

Hall, R.E., Mammals of Nevada, University of California Press, Berkeley, California, 1946.

Hamilton, W. J., Jr., American Mammals, McGraw-Hill Book Company, Ltd., New York and London, 1939.

Hannum, Gordon, W. Anderson, and M. Nelson, Powerlines and Birds of Prey, paper presented at the Northwest Electric Light and Power Association, Engineering and Operating Conference, Yakima, Washington, April 22, 1974.

Harrington, M. R., "The Fossil Falls Site," The Masterkey, Southwest Museum publications, Los Angeles, California, 1952, 26 (6): 191-195.

Hession, Edwin A. and Frederick P. Frampton, "Phase I Archaeological and Environmental Research: Kaiparowits Power Project, Arizona Public Service, Kaiparowits to Westwing Power Line." Ms. Museum of Northern Arizona, Dept. of Anthropology, Flagstaff, 1974.

Hester, Thomas Roy, Chronological Ordering of Great Basin Prehistory, contributions of the University of California Archaeological Research Facility, No. 17, Berkeley, California, 1973.

Higbee, Edward, Farms and Farmers in an Urban Age, The Twentieth Century Fund, New York, 1963.

Hill, A.C., W.H. Edwards, T.W. Barrett, K.T. Harper, C. Leathers, M. Treshow, H.E. Price, Air Pollution Investigations in the Vicinity of the Four Corners and San Juan Power Plants. Progress report. Utah Engineering Experiment Station. University of Utah, March 1973a.

_________, W.H. Edwards, W. Ursenbach, Air pollution investigations in the vicinity of the Mohave power plant of Southern California Edison Company. Utah Engineering Experiment Station, University of Utah, Salt Lake City, Utah, 1973b.

_________, W.O. Ursenbach, N. de Nevers, Hearings of proposed regulations to prevent significant deterioration. Environmental Protection Agency Hearings September 5-6, 1973. Denver, Colorado. Utah Engineering Experiment Station. University of Utah, Salt Lake City, Utah, 1973.

Hornocker, M. G., "An Analysis of Mountain Lion Predation Upon Mule Deer and Elk in the Idaho Primitive Area," Wildl. Mono. No. 21, Wildl. Soc., Washington, D. C., 1970.

Horton, J. S., Vegetation types of the San Bernardino Mountain, California, Technical Paper No. 44, U.S. Dept. of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, 1960.

Houghton, John G., "Great Basin Precipitation Estimates for Short-term Records," The Professional Geographer, February 1974, Vol. XXVI, No. 1, pp. 26-33.

Huff, Clair L., and Jim E. Bowns, Utah Big Game Range Inventory, Publication No. 65-1, Utah State Department of Fish and Game (now Utah State Division of Wildlife Resources), 1964.

Humphrey, Arizona Natural Vegetation, Experiment Station and Coop. Extension Service, Bull. A-45 (map), University of Arizona, 1963.

Irvine, Charles A., The Desert Bighorn of Southeastern Utah,Publication Number 69-12, Utah State Division of Fish and Game, (now Utah State Division of Wildlife Resources), 1969.

Jaeger, E. C., Desert Wild Flowers, Stanford University Press, Stanford, California, 1969.

Jefferson, G. T., Investigations in Progress, Department of Anthropology, University of California, Riverside, 1971.

Jennings, C. W., Geologic Map of California, Salton Sea Sheet, scale 1:250,000, California Division of Mines and Geology, 1967.

Jennings, Jess D., "Glen Canyon: A Summary," Anthropological Papers, No. 81, Glen Canyon Series No. 31, University of Utah, Salt Lake City, 1966.

Jeppson, R. W., Ashcroft, G. L., Huber, A. L., Skogerboe, G. V., and Bagley, J. M., Hydrologic Atlas of Utah, Utah Water Research Laboratory, Utah Agricultural Experimental Station, Utah State University in Cooperation with Division of Water Resources, Utah Department of Natural Resources, 1968, pages 33-55.

Johns, R. H., "Geology of the Peninsular RAnge Province, Southern California and Baja California," in Geology of Southern California, Bull. 170, California Division of Mines, 1954.

Johnsgard, P. A., Grouse and Quails of North America, Univ. of Neb., Lincoln, Neb., 1973.

Johnson, Frank, The Serrano Indians of Southern California, Malki Museum, Brochure No. 2, Banning, 1965.

Johnston, Francis J. and Patricia H., An Indian Trail Complex of the Central Colorado Desert: A Preliminary Survey, Report No. 37, University of California Archaeological Survey, Berkeley, California, 1957, pp. 22-39.

Joint Meteorological Report, prepared for Navajo project, Mohave project, San Juan project, Four Corners project, Huntington Canyon project. Contributors were Dames and Moore, North American Weather consultants, Loren W. Crow, R.G. Larsen, and A.C. Hill. September 1, 1971.

Joint Panel on Problems Concerning Seismology and Rock Mechanics, Earthquakes Related to Reservoir Filling, Nat. Tech. Info. Ser., PB-208327, 1972.

Kearney, T. H. and R. H. Peebles, Arizona Flora, Second Edition, University of California Press, Berkeley, California, 1960.

Kochert, M. N., "Population Status and Chemical Contamination in Golden Eagles in Southwestern Idaho." M.S. Thesis. Univ. of Idaho, Moscow, 1972.

Kormondy, E. J. Concepts of Ecology, Prentice-Hall Biological Science Series. Englewood Cliffs, N.J., 1969.

Knecht, Arnold A., Soil Survey of Western Riverside Area, California, U.S. Dept. of Agriculture, Soil Conservation Service, Washington, D.C., 1971.

Kroeber, A.L., "Handbook of the Indians of California," Bureau of American Ethnology Bulletin 78. Washington, 1925.

Robert, and Donald Moore, Interim Inventory of Surface Water Resources of Nevada, Water Resources Bull. No. 30, State of Nevada Dept. of Conservation and Natural Resources, 1965.

LaRivers, I. Fishes and Fisheries of Nevada, Nev. State Fish and Game Comm., Carson City, Nev., 1962.

Leakey, L.S.B., R.D. Simpson and T. Clements, "Archaeological Excavations in the Calico Mountains, California: Preliminary Report," Science, Washington, 1968, Vol. 160, pp. 1022-1023.

Leopold, Wolman and Miller, Fluvial Processes in Geomorphology, W. H. Freeman and Company, 1964.

Lindsay, LaMar, "A Preliminary Survey of Archaeological Values and Recreation Potentials of the Kaiparowits Impact area, Kane County, Utah," Manuscript on file at the Bureau of Land Management State Office, Salt Lake City, Utah, 1974.

Linsdale, J. M., Amphibians and Reptiles of Nevada. Univ. of Calif., Berkeley, Calif., 1938. p. 19-257.

Lister, Florence C., "Kaiparowits Plateau and Glen Canyon Prehistory: An Interpretation Based on Ceramics," Anthropological Papers, No. 71, University of Utah, Salt Lake City, 1956.

Littell, Norman M., "Proposed Findings of Fact in Behalf of the Navajo Tribe of Indians in Area of the Overall Navajo Claim," Indian Claims Commission, Vol. II, Findings 13-14.

Longwell, C.R., Geology of the Muddy Mountains, Nevada, U.S. Geological Survey, Bull. 798, 1928.

__________, E.H. Pampeyan, B. Bowyer and R.J. Roberts, Geology and Mineral Deposits of Clark County, Nevada, Nevada Bureau of Mines, Bull. 62, 1965.

Lowe, C. H., University of Arizona, and D. E. Brown, Arizona Game and Fish Department, The Natural Vegetation of Arizona, published by Arizona Resources Information System, 1973.

Lower Colorado Region, State-Federal Interagency Group, Lower Colorado Region Comprehensive Framework Study, Pacific Southwest Interagency Committee, 1971, Appendices V, X, XI, XV.

Lower Colorado River Land Use Plan, 1964.

Maricopa County Comprehensive Plan, Part III, 1975.

Marshall, Larry G. and William J. Breed, "Phase I Report for Paleontological Investigations: Kaiparowits Power Project," Ms. Museum of Northern Arizona, Dept. of Geology, Flagstaff, 1974.

Martin, Paul S. and Fred Plog, Archaeology of Arizona. Doubleday Natural History Press, Garden City, 1973.

Master Plan of Washington County, Utah, 1971.

McGahan, J., Ecology of the Golden Eagle, M. A. Thesis, University of Montana, Missoula, Montana, 1965.

McGavock, E. H., Basic Ground Water Data for Southern Coconino County, Arizona, Arizona State Land Dept., Water Resources Report No. 33, Phoenix, Arizona, 1968.

McGregor, John C., Southwestern Archaeology, Second Edition, University of Illinois Press, Urbana, 1965.

McHarg, I.L., Design with Nature, Doubleday and Company, Inc., 1969.

McKee, J.E., and Wolf, H.M., Water Quality Criteria 2nd Edition, State Water Quality Council Board Publication 3A, The Resources Agency of California; 1953.

Meteorology and Atomic Energy, David H. Slade, Editor. U.S. Atomic Energy Commission, Division of Technical Information, 1968.

Miller, R.D. and P.J. Miller, "The Chemehuevi Indians of Southern California," Malki Museum Brochure No. 3, Banning, 1967.

Minckley, W. L., Fishes of Arizona, Arizona Game and Fish Dept., Sims Printing Company, Inc., Phoenix, Arizona, 1973.

Mindling, A., A Summary of Data Relating to Land Subsidence in Las Vegas Valley, Desert Research Institute, Reno, Nevada, 1971.

Moen, A. N. Wildlife Ecology, an Analytical Approach. W. H. Freeman and Comp., San Francisco, Calif. 1973.

Montgomery, T.L., S.B. Carpenter, W.C. Colbauga, and F.W. Thomas, "Results of Recent TVA Investigations of Plume Rise." Air Pollution Control Assoc. Journal 22:10, 1972, 779-784.

Moody, Ralph, The Old Trails West, Thomas Y. Crowell Company, New York, 1963.

Moore, D.O., Estimating Mean Annual Runoff in Ungaged Semiarid Regions, Water Resources Bulletin 36, Nevada Dept. of Conservation and Natural Resources, 1968.

Moore, R.T., Geology of the Virgin and Beaver Dam Mountains, Arizona, University of Arizona, Bull. 186, 1972.

Mountain Area Planners, Garfield County Preliminary Master Plan, Salt Lake City, Utah, 1971.

Munz, P. A., A California Flora and Supplement, University of California Press, Berkeley, California, 1968.

________, A Southern California Flora, University of California Press, Berkeley, California, 1974.

Museum of Northern Arizona, Archaeology and Paleontology, Report Phase I.

National Park Service. Camping in the National Parks System, Washington, D. C., 1973.

Nelsen, M. W., "The Status of the Peregrine Falcon in the Northwest," Peregrine Falcon Populations - Their Biology and Decline, edited by Joseph J. Hickey, University of Wisconsin Press, Madison, Wisconsin, 1964, 4:61-72.

O'Dea, Thomas F., The Mormons, The University of Chicago Press, Chicago, Illinois, 1957.

Odum, E.P., Fundamentals of Ecology. W. B. Saunders Comp., Philadelphia, Penn. 1959.

______, Ecology, Modern Biology Series. New York, 1963.

Office of the State Planning Coordinator, "Inter-governmental Planning Coordination," The Utah Experience, June 1974.

Olendorff, R.R., "Eagles, Sheep and Powerlines," Colorado Outdoors, Colo. Dept. of Fish and Game, Denver, Colo., 1972. 1:3-11.

Ornduff, R., Introduction to California Plants, University of California Press, Berkeley, California, 1974.

Oxford, Richard B. and Gordon L. Benher, Proposed National Area - Report No. 36: Joshua Tree, prepared for Arizona Academy of Science for Arizona Dept. of Economic Planning and Development, 1973.

Pacific Security National Bank, Monthly Summary of Business Conditions, 1973-1974.

________, The Southern California Report, 1970.

Page, J. L. and D. J. Seibert, Inventory of Golden Eagle Nests in Elko County, Nevada, California-Nevada Wildlife Trans. of the Western Section of the Wildlife Society, 1973, pp. 1-8.

Palmer, R. S., The Mammal Guide, Mammals of North America North of Mexico, Doubleday and Company, Inc., Garden City, N.Y., 1954.

Pacific Southwest Inter-Agency Committee for the U.S. Water Resources Council, Water and Land Resources, November 1971.

________, Comprehensive Framework Study-California Region, Appendix V, Water Resources and Appendix XV, Water Quality, Pollution and Health FActors, June 1971.

Peterson, F.D., Minerals Portions of the URA for the Paria Planning Unit, Smoky Mountain Area, Bureau of Land Management, 1970.

Peterson, Fred, Four new members of the Upper Cretaceous Straight Cliffs Formation in the southeastern Kaiparowits region, Kane County, Utah: U.S. Geological Survey Bulletin. 1274-J, 1969, 1-28.

________Goal Evaluation of Proposed Plant Sites, Kaiparowits Coal Field, USGS, unpublished report, 1974.

Planning and Research Associates, Kane County Master Plans, Salt Lake City, Utah, 1970.

Planning Dept. of Clark County, General Plan and Land Use Inventory for the Unincorporated Portions of the Las Vegas Valley, 1974.

Plummer, P. A., D. R. Christensen and S. B. Monsen, Restoring Big-game Range in Utah, Forest Serv. Intermountain Forest and Range Exp. Sta., Ephraim, Utah, 1968.

Prenzlow, E. J., A Literature Review on Pronghorn Behavior, Spec. Rep. No. 3, Colo. Game, Fish and Parks Dept., Research Div., Denver, Colo., 1965.

Prong, R.H., EAR for Nevada Power Company McCullough Clark 230 kv Transmission Line, N-7299, Bureau of Land Management, 1973.

Reynolds, Robert E., "A Discussion of Paleontologic Values Along the Proposed Southern California Edison Kaiparowits Transmission Line in California," Ms. San Bernardino County Museum, Bloomington, 1974.

Riverside County Air Pollution District Annual Reports, 1959-1971.

Riverside County Conservation and Open Space General Plan Elements, 1973.

Riverside County General Plan - Land Uses, Highways, and Recreation, 1966.

Riverside County San Gorgonio Pass General Plan Technical Report, 1971.

Richardson, E. Arlo, Estimated Return Periods for Short Duration Precipitation in Utah, Utah State University, Department of Soils and Biomet., Bull. No. 1, March 1971.

Rocky Mountain Association of Geologists, Geologic Atlas of the Rocky Mountain Region: Rocky Mountain Assoc. Geo., Denver, 1972.

Rogers, M. J., "An Outline of Human Prehistory," Southwestern Journal of Anthropology, Albuquerque, New Mexico, 1945, 1(2): 167-198.

________, Early Lithic Industries of the lower Basin of the Colorado River and Adjacent Desert Areas, San Diego Museum Papers 3, 1939.

________, Ancient Hunters of the Far West, Copley Books, San Diego, 1966.

Ruby, Jay W., "Excavations at One Horse Canyon Rock Shelter (Rev. 8)," UCLA Archaeological Survey, Annual Report Appendix 1, Los Angeles, 1964.

_________, and Wayne Alexander, "Archaeological Resources of the Willow Hole Area, Riverside County, California," Ms. report to U. S. Dept. of Interior, Bureau of Land Management, Riverside, California 1964.

Rush, Eugene, Ground Water Resources - Reconnaissance Series Report 27, State of Nevada Dept. of Conservation and Natural Resources, July 1964.

_______, Water Resources - Reconnaissance Series Report 50, December 1968.

San Bernardino County Air Pollution Control District, 1971 Annual Report, San Bernardino, California.

San Bernardino County Conservation and Open Space General Plan Elements, 1973.

San Bernardino County General Plan, 1966.

Saltzman, B.E., "Colorimetric Micro-determination of Nitrogen Dioxide in the Atmosphere." Anal. Chem. 26: 1949-1955, 1954.

Savage, D.E. and T. Downs, "Cenozoic Land Life of Southern California," California Division of Mines and Geology Bulletin 170, Sacramento, 1954.

Schaefer, V. J., "Fine Particle Concentrations in the Southwest." Report to Bechtel Power Corporation, May 10, 1973.

Schumacher, J., U.S.B.R., Davis Dam, Arizona. Oral communication, April 13, 1975.

Schwartz, Douglas W., "A Historical Analysis and Synthesis of Grand Canyon Archaeology." American Antiquity, Salt Lake City, 1966, Vol. 31, No. 4, pp. 469-84.

SCS, Guide for Interpreting Engineering Uses of Soils. U. S. Department of Agriculture, Soil Conservation Service, 1971.

Seibert, D. J., and J. L. Page, Inventory of Golden Eagle Nests in Elko County, Nevada, Bureau of Sport Fisheries and Wildlife and Bureau of Land Management, 1973.

Shown, L. M., Evaluation of a Method for Estimating Sediment Yield. U. S. Geological Survey Professional Paper 700-B, 1970, Pages B245-B249.

Simpson, J. H., Report of Explorations Across the Great Basin of the Territory of Utah for a Direct Wagon-Route From Camp Floyd to Genoa, in Carson Valley, 1859. 518 pp., Illus. Govt. Print. Off. Washington, D. C., 1876.

Simpson, R. D., "The Manix Lake Archaeological Survey," The Masterkey, Southwest Museum, Los Angeles, California, 1958, 32 (1): 4-9.

Sitgreaves, Lorenzo, "Report of an Expedition down the Zuni and Colorado Rivers," U. S. Senate Executive Document 59, 32nd Congress, 2nd Session. Washington, 1853.

Snow C., "American Peregrine Falcon and Arctic Peregrine Falcon," Habitat Management Series for Endangered Species, Report No. 1, Bureau of Land Management, 1972.

_______, "Golden Eagles, Aquila chrysaetos," Habitat Management Series for Unique or Endangered Species, Report No. 7, Bureau of Land Management, 1973.

________, "Prairie Falcon, Falco mexicanus," Habitat Management Series for Unique or Endangered Species, Report No. 8, Bureau of Land Management, 1974.

Soil Map for Mohave County (unpublished).

Southern California Edison Company, Kaiparowits Transmission System Environmental Report, 1974.

_______, Kaiparowits Transmission System Route Feasibility Study, Devers-Mohave 500 kv Transmission Line, 1974.

_______, Kaiparowits Transmission System Route Feasibility Study, Devers-Serrano (Via Valley) 500 kv T/L, 1974.

________, Resource Data, 1974.

_______, Route Feasibility Study, May 1974.

_______, Transmission Alignment Study, 1971.

Southwest Energy Study, Report of the Indian Work Group, U.S. Department of the Interior, 1972.

________, Report of the Mining Work Group, Appendix K, 1972, pp. 35-46.

Spangler, T. C., A. J. Anderson and E. L. Hovind, A smoke tracer plume simulation study at the Kaiparowits Power Generating Station during November 1973. A Report prepared for Southern California Edison Company by North American Weather Consultants, December 6, 1973.

________, J. F. Boatman, A. J. Anderson, M. W. Edelstein and E. L. Hovind, Meteorological tracer study for the evaluation of the Kaiparowits plant site. A report to Southern California Edison Company, July 31, 1974.

Sparkman, Philip S., "The Culture of the Luiseno Indians," Publications in American Archaeology and Ethnology, University of California, Berkeley, Calif., 1908, 8 (4).

Speltz, C. N. and H. B. McCann, Personal communication. U. S. Geological Survey, Salt Lake City, Utah, 1974.

Spencer, E. W., Basic Concepts of Historical Geology, T. Y. Croswell Company, New York, 1962.

Standiford, D. R., Potter L. D., and Kidd, D. E., Mercury in the Lake Powell Ecosystem, Lake Powell Research Project, Lake Powell Research Project Bulletin No. 1, 1973.

State Engineer, Division of Water Resources, Estimated Water Use in Nevada, State of Nevada Water Planning Report, January 1971.

________, Nevada's Water Resources, State of Nevada Water Planning Report, October 1971.

________, Water Supply for the Future in Southern Nevada, State of Nevada Special Planning Report, January 1971.

State of Arizona, Arizona Outdoor Recreation Coordinating Commission, Statewide Comprehensive Outdoor Recreation Plan, 1973.

State of Utah, Department of Natural Resources, Outdoor Recreation Agency. Utah Outdoor Recreation Plan, 1972. Salt Lake City, Utah, 1973.

Stebbins, Robert C., A Field Guide to Western Reptiles and Amphibians, Houghton Mifflin Company, Boston, Mass., 1966.

Stone, Joseph L., and Ned L. Rathbun, Lake Powell Fisheries Investigations - Creel Census and Plankton Studies, Arizona Game and Fish Department, 1968.

Stone, Roderick, et al., Glen Canyon Reservoir Post Impoundment Investigations, Progress Report No. 5, Utah State Division of Fish and Game (now Utah State Division of Wildlife Resources), 1967.

Storer, T.I. General Zoology. McGraw-Hill Book Company, New York, 1943.

Strong, W.D., Aboriginal Society in Southern California, University of California Press, Berkeley, California, 1929.

Sulenski, R.J., Unit Resource Analysis Virgin Valley and Stateline Planning Units, Bureau of Land Management, Las Vegas District files, 1973.

Sundstrom, C., W. G. Hepworth, and K. L. Diem. Abundance Distribution and Food Habits of the Pronghorn, Bull. No. 12, Wyo. Game and Fish Comm., 1973.

Swank, W. G., The Mule Deer in Arizona Chaparral, Wildl. Bull. No. 3, State of Arizona Game and Fish Dept., Phoenix, Ariz., 1958.

Tabor, E.C., and C.D. Golden, "Results of Five Years Operation of the National Gas Sampling Network." J. of Air Pollution Control Association, 1965, 15: 7-11.

Taylor, W. P., The Deer of North America, the Stackpole Company, Harrisburg, Pennsylvania, 1956.

The Water Encyclopedia, edited by David Keith Todd, 1970.

Trippensee, R. E., "Upland Game and General Principles," Wildlife Management, McGraw-Hill Book Company, New York, 1948, Vol. I.

______, "Fur Bearers, Waterfowl, and Fish," Wildlife Management, McGraw-Hill, New York, N.Y., 1953, Vol. II.

Tsukamoto, J. K. and W. J. Deibert, A Preliminary Report of Nevada Pronghorn Antelope Food Habits During August and September, Trans. Interstate Antelope Con., 1917-13, 1968.

Upper Colorado Region, State-Federal Interagency Group, Upper Colorado Region Comprehensive Framework Study, Pacific Southwest Interagency Committee, 1971, Appendices V, X, XI, XV.

U. S. Dept. of Agriculture, Forest Service, Cholla Project Draft Environmental Statement, 1974.

________, Environmental Impact Statement, Cholla Project, 1974.

________, Environmental Statement of a Proposal to Construct Two 500 kv Powerlines Across National Forest Land by APS, 1971.

________, Forest Landscape Description and Inventories - A Basis for Land Planning and Design, Research Paper PSW-49, Pacific Southwest Forest and Range Experiment Station, Berkeley, California, 1968.

________, Kaibab National Forest Recreation Management Plan.

________, Prescott National Forest Multiple Use Guides, 1974.

________, Prescott National Forest Recreation Management Plan.

________, Recreation Information Management System, Kaibab and Prescott National Forests.

U.S. Dept. of Agriculture, Soil Conservation Service, General Soil Maps for Coconino County and Yavapai County, 1972.

_______, General Soil Maps for Mohave and Maricopa Counties, 1974.

________, General Soil Map, Orange County, California, Portland, Oregon, 1966.

U. S. Dept. of Commerce, ESSA, Weather Bureau, Office of Hydrology, Special Studies Branch, Precipitation-Frequency Maps for Utah, Washington, D. C., July 1968.

U. S. Dept. of Commerce, NOAA, Environmental Data Service, Climatological Data, 1931 to 1974.

U. S. Dept. of Commerce, NOAA, National Climatic Center, Asheville, N.C., Climatic Atlas of the United States, June 1968.

________, Climatological Data: Utah (monthly records: 1969 - June 1974; annual summaries; 1956-1973).

_______, Utah: Monthly Normals of Temperatures, Precipitation, and Cooling Degree Days, 1941-1970, (Climatography of the U.S., No. 1).

U. S. Dept. of Interior, Bureau of Land Management, Archaeological Resources of Black Canyon Planning Unit of BLM, Prescott College, June 1974.

________, Arizona Outdoor Recreation Comprehensive Plan Unit Resource Analysis, Black Canyon Planning Unit.

________, Draft Environmental Statement for the Sale of Fort Mohave Lands to the State of Nevada, 1972.

_______, Detailed Analysis, Coachella Valley Program Area, 1964.

________, Detailed Analysis, Perris Valley Program Area, 1963.

_________, Environmental Analysis Record, Interim Critical Management Program for Recreation Vehicle Use of the California Desert, Riverside, California, 1973.

______, Lower Colorado River Cooperative Planning Area, Special Economic Supplement, 1971.

________, Management Framework Plan for the Vermillion Planning Unit, Kanab District, Utah.

________, Paria Planning Unit Management Framework Plan, Kanab District, Utah.

________, Paria Planning Unit Resource Analysis, Kanab District, Utah.

_______, Providence Mountains Administrative Unit Watershed Plan, 1965.

________, Range Survey 1963-64, Kanab District, Utah, 1964.

________, Socio-economic Data System, Kanab District, Utah, June 1973 - March 1974.

________, The California Desert, 1968.

________, The Impact of Transmission Lines, September 1970.

________, Unit Resource Analysis, Barstow Planning Unit, 1969.

______, Unit Resource Analysis, Victorville-Twentynine Palms, 1970.

______, Unit Resource Analysis Report, Black Canyon Planning Unit, 1973.

______, Unit Resource Analysis of Virgin Valley Planning Unit, Cedar City District, Utah.

U. S. Dept. of the Interior, Bureau of Land Management, Washington, D. C., and U. S. Dept. of Agriculture, Washington D. C., Environmental Criteria for Electrical Transmission Systems, Superintendent of Documents, U. S. Govt. Printing Office, Washington, D. C., 1970.

U. S. Dept. of Interior, Bureau of Reclamation, Environmental Impact Statement, Navajo Project, 1972.

______, Navajo Project Final Environmental Statement, 1972.

______, Quality of Water, Colorado River Basin, U. S. Bureau of Reclamation Progress Report No. 6, January 1973.

U. S. Dept. of Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Rare and Endangered Fish and Wildlife of the United States, Resource Publ. No. 34, 1968.

______, Threatened Wildlife of the United States. Resource Publ. No. 114, 1973.

______, United States List of Endangered Fauna, Washington, D. C., 1974.

U. S. Dept. of Interior, National Park Service, Draft Environmental Statement of Proposed Wilderness Areas: Lake Mead National Recreation Area, Arizona and Nevada, 1974.

U. S. Geological Survey, Bureau of Mines, California Division of Mines and Geology, prepared for Committee of Interior and Insular Affairs - United States Senate, Mineral and Water Resources of California, 1966.

U. S. Geological Survey, Annual Report on Ground Water in Arizona, Spring 1972 to Spring 1973; Arizona Water Commission Bulletin 7, Arizona Water Commission, Phoenix, Arizona, April 1974.

______, Quality of Ground water in the Lower Colorado River Region, Arizona, Nevada, New Mexico, and Utah; Hydrologic Investigation Atlas HA - 478, U. S. Geological Survey, Washington, D. C., 1973.

______, The Borrego Mountain Earthquake of April 9, 1968, U.S.G.S. Professional Paper 787, 1972.

______, Water Resources Data for Arizona in 1968; U. S. Geological Survey, Washington, D. C., 1969, Parts 1 and 2.

______, Water Resources Data for California in 1966; U. S. Geological Survey, Washington, D. C., 1967, Parts 1 and 2.

______, Water Resources Data for California in 1971; U. S. Geological Survey, Washington D. C., 1972, Parts 1 and 2.

______, Water Resources Data for Nevada in 1971; U. S. Geological Survey, Washington, D. C. 1972, Parts 1 and 2.

U. S. Public Health Service, Drinking Water Standards, Public Health Service Publication 956, U. S. Department of Health, Education and Welfare, Washington, D. C.: 1962.

U. S. Salinity Laboratory Staff, Diagnosis and Improvement of Saline and Alkali Soils, Department Agriculture Handbook 60, U. S. Dept. Agriculture, 1954.

Utah Division of Wildlife Resources, "Colorado River Drainages and Reservoirs Fisheries Management Investigations and Surveys," Annual Progress Report for 1972, Salt Lake City, Utah, 1973.

________, Utah Big Game Harvest - 1973, Publication #74-4, Salt Lake City, Utah, 1974.

Utah Industrial Promotion Division, Utah File (n.d.).

Van der Hoven, I., G. L. Ferber, P. A. Humphrey, G. C. Holzworth, J. L. Hefter, R. F. Quiring, Report of the Meteorology Group, Southwest Energy Study, Appendix E, March 1972.

Vickers, Samuel E., Page, Arizona: A Study of Factors Affecting Incorporation of a "Federal" Community, Institute of Public Administration, Arizona State University, Tempe, Arizona, 1968, Vol. 7, No. 3.

Volberth, A., Geology of the Granite Complex of the Eldorado, Newberry, and Northern Dead Mountains, Clark County, Nevada, Nevada Bureau of Mines and Geology, Bull. 80, 1973.

Waldrop, H. A. and R. L. Sutton, Preliminary Geologic Map and Coal Deposits of the Southwest Quarter of the Nipple Butte Quandrangle, Kane County, Utah and Coconino County, Arizona: Utah Geological and Mineralogical Survey, Salt Lake City, Utah, 1966.

Wallace, W. J., "Prehistoric Cultural Development in the Southern Californian Deserts," American Antiquity, Salt Lake City, Utah, 1962, 28 (2): 172-180.

________, and E. S. Taylor, "A preceramic Site at Saratoga Springs, Death Valley National Monument," Contributions to California Archaeology, 1959, 3 (2): 1-13.

Walther, E. G., M. D. Williams, R. Cudney, "Air Quality in the Lake Powell Region." Lake Powell Research Project Bulletin No. 3, August 1974.

Warren, C. N., "The San Diequito Complex: A Review and Hypothesis," American Antiquity, Salt Lake City, Utah, 1967, 32 (2):168-185.

Weaver, Richard A., Conclusion of the Bighorn Investigation in California, California Department of Fish and Game, 1973.

West, P. W. and G. C. Gaeke, "Fixation of Sulfur Dioxide as Disulfilomercurate (II) and Subsequent Colorimetric Estimation." Anal. Chem., 1956, 28: 1816-1819.

Western Regional Soil Survey Work Group, Washington State University, Agricultural Experiment Station, Soils of the Western United States, map scale: 1:25,000,000, 1964.

White, Natalie D., R. S. Stalik, and E. K. Morse, Annual Report on Ground Water in Arizona, Spring 1962 to Spring 1963, Water resources Report No. 15, 1963, Arizona State Land Department.

Wildesen, Leslie E., "Archaeological Impact Evaluation: Southern California Edison Company Proposed HTGR Nuclear Power Plant in Vidan Valley, California, and Associated Transmission Line Routes," Ms. Archaeological Research Unit, Dry Lands Research Institute, University of California, Riverside, 1974.

______, "Ethnographic and Archaeological Background: Southern California Edison Proposed Kaiparowits Transmission Line, Phase I Report," Ms. Archaeological Research Unit, Dry Lands Research Institute, University of California, Riverside, 1974.

Wilke, Philip J., "Wide Canyon Channel: Expected Impact on Archaeological Values," Ms. Department of Anthropology, University of California, Riverside, 1973.

Williamson, M. A., "Heloderma Suspectum," Symposium of Rare and Endangered Wildlife of the Southwestern United States, N. Mex. Dept. of Game and Fish, Santa Fe, N. M., 1972, p. 114-117.

Willie, John C., Kaiparowits New Town Site Analysis and Revision Study, 1974.

_______, Kaiparowits New Town Study, St. George, Utah, 1972.

Wilson, C. L. and W. E. Loomis, Botany. Holt, Rinehart and Winston, Inc. 1952.

Wilson, E. D., A Resume of the Geology of Arizona, Arizona Bureau of Mines, Bull. 171, 1962.

Wilson L., Olsen, M. E., Hutchings, T. B., Southard, A. R., and Erickson, A. J., Soils of Utah. Agricultural Experimental Station Bulletin 492, Utah State University, Logan, Utah, 1975.

Wirth, Theodore J. and Associates, Kaiparowits Land Use and Environmental Study, 1972.

Wormington, H. Marie, "Prehistoric Indians of the Southwest." Denver Museum of Natural History Popular Series No. 7., Denver, 1956.

Yoakum, J., "Bighorn Food Habit-Range Relationships in the Silver Peak Range, Nv." Desert Bighorn Council Trans., 1964, 8:95-99.

________, and W. P. Dasmann, Habitat Manipulations Practices, Wildl. Management Tech., The Wildl. Soc., Washington D. C. 1969, 14:173-231.

________, Pronghorn Antelope Habitat Requirements for Sagebrush Grassland Biome. 1972.

Young, S. P., and E. A. Goldman, The Puma Mysterious American Cat, Dover Publ. Inc., N. Y., N.Y. 1946, p. 27.

_________, and H. T. Jackson, The Clever Coyote, The Stackpole Comp., Harrisburg, Pa., 1957.

1970 Census of Population, "General Social and Economic Characteristics--U. S. Summary."

1970 Census of Population, "General Social and Economic Characteristics--Utah."

1970 Census of Population, "Number of Inhabitants--Utah."

BIBLIOGRAPHY

CHAPTER III

Air Pollution Control District, County of Los Angeles, Major Point Sources of Air Pollution in Los Angeles County. April, 1973.

Allred, D.M., Navajo Generation Station Ecological Baseline Study. Annual Report 6/1/71-6/1/72 BYU Press. Provo, Utah, 1972.

Arizona Commission of Agriculture and Horticulture, Arizona Native Plant Law, Arizona Revised Statutes, Chapter 7, 1972.

Arizona Highway Department, Arizona Traffic 1973. Phoenix, Arizona, 1974.

Atomic Energy Commission, "Concentrations in Air and Water above Natural Background." Code of Federal Regulations, Title 10, Part 20, Appendix B. November 5, 1973.

Bagley, J.M., Jeppson, R.W., and Milligan, C.H., Water Yields in Utah, Special Report 18, Utah State Agricultural Experiment Station, Utah State University, Logan, Utah, 1964.

Barnes, C.T., The Cougar or Mountain Lion, The Ralton Co., Salt Lake City, Utah 1960. p. 71-85.

Barrett, R.H., "Seasonal Food Habits of Bighorn at the Desert Game Range, Nev.," Desert Bighorn Council Trans. 1964, 8: 85-93.

Baver, L.D., Soil Physics. John Wiley and Sons, Inc., New York, N.Y., 1959, Pages 227-234.

Beale, D.M., The Relationship of Range Conditions to Pronghorn Antelope Productivity and Survival, Utah State Dept. Fish and Game, Fed. Aid Job Completion Rept., Proj. No. W-105-R-2, 1966.

________and G.W. Scotter, "Seasonal Forage Use by Pronghorn Antelope in Western Utah." Utah Science, Agric. Exp. Sta., Logan, Utah, 1968, 29:1.

Bechtel Power Corporation, "Environmental Engineering Studies: Gaseous Effluent and Visibility Study," Report prepared for Southern California Edison Company, July, 1974a.

______, "Environmental Engineering Studies and Cooling Tower Drift and Fogging Study for the Kaiparowits Generating Station." Report to Southern California Edison Co., June, 1974b.

______, "Environmental Engineering Studies: Particulate and Sulfur Dioxide Removal Study, Kaiparowits Generating Station." Report to Southern California Edison Co., July, 1974.

Bent, A.C., Life Histories of North American Birds of Prey, Dover Publ. Inc., N.Y. Rep. 1937. 1961, Part I.

________, Life Histories of North American Birds of Prey, Dover Publ. Inc., N. Y. Rep. 1937. 1961, Part II.

________, Life Histories of North American Gallinaceous Birds, Dover Publ. Inc., N. Y. rep. 1932. 1963, p. 40-43.

Bernstein, L., Salt Tolerance of Grasses and Forage Legumes. U.S.D.A., Agri. Info. Bull. No. 194, 1958.

Bond, F. M., "Falcons". Symposium on Rare and Endangered Wildlife of the Southwestern United States. N. Mex. Fish and Game Dept., 1972, p. 51-55.

"Boom Towns," High Country News. Lander, Wyoming, June 7, 1973.

Brauner, Gerhard, Subsidence Due to Underground Mining, in two parts. Part 1: Theory and Practices in Predicting Surface Deformation, Bureau of Mines, I. C. 8571, 1973, 1-56.

Brigham Young University and Northern Arizona University, Environmental Studies

____

of

____

Theory and Practices

Brigham Young University and Northern Arizona University, Environmental Studies of the Navajo and Kaiparowits Generation Stations. 1971-1974.

Brigham Young University, Center for Business and Economic Research, Kaiparowits Socio-Economic Study. Provo, Utah, February 1973.

Buechner, H. K., The Bighorn Sheep in the United States, Its Past, Present and Future. Wildl. Mono. No. 4 Wild. Soc., 1960.

Cain, D., The Ely Chain, Bureau of Land Management, Ely, Nev., 1971.

Calalane, V. H., Cougar, Grizzly, and Wolf in North America, N. Y. Zool. Soc., 1964.

California Air Resources Board, Oxidant Trends in the South Coast Air Basin, 1963-1972. April 1973.

________, Ten-Year Summary of California Air Quality Data, 1963-1972. January, 1974.

California Environmental Quality Study Council, Environmental Quality in California: A Strategy for Action. March 1972.

________, Progress Report. Feb. 1970.

California Native Plant Society, Inventory of Rare, Endangered, and Extinct Vascular Plants of California, 1972.

Call Engineering Inc., Kaiparowits New Town, Environmental Impact Data, Call Engineering, Inc., Salt Lake City, Utah, 1974.

Carpenter, S.B., T.L. Montgomery, J.M. Leavitt, W.C. Colbaugh, F.W. Thomas, "Principal Plume Dispersion Models; TVA Power Plants." J. of Air Pollution Control Association, 1971, 21: 491-495.

Charlson, R.J., "Atmospheric Visibility Related to Aerosol Mass Concentration," Environmental Science and Technology, 1969, 3: 913.

Coombs, E. M., Desert Tortoise, Gopherus agassizi, study progress report, summer 1973 in the Beaver Dam Wash area. Bureau of Land Management, Cedar City, Utah 1973.

Corn, M., "Nonviable Particles in the Air," In Stern, A. C. Air Pollution, Academic Press, 1969, Volume 1, p. 47.

Cummins, Arthur B. and Ivan A. Given, SME Mining Engineering Handbook, in two volumes, 1973, Vol. I, Sec. 13.1.

Dasmann, R. F., Biomass, Yield and Economics Value of Wild and Domestic Ungulates. Proc. Union Inter. Game Biologist. Bournemouth, England, 1964.

Dasmann, W., If Deer are to Survive. Wildl. Manage. Inst. Stackpole Books, Harrisburg, Penna., 1971.

Daubenmire, R., Plant Communities, a Textbook of Plant Synecology. Harper & Row Publishers, New York, 1968.

DeCalesta, D. S., A Literature Review of Cottontail Feeding Habits, Spec. Rep. No. 25, Colo. Div. of Game, Fish and Parks, Denver, Colo., 1971.

Drewien, G., Food Habits and Weight Relationships of Mourning Doves in Northern Nevada. M. S. Thesis. Univ. of Nev., 1971.

Dunaway, D. J., Human Disturbance as a Limiting Factor of Sierra Nevada Bighorn Sheep. First North American Wild Sheep Conference, April 14-15, Colo. State Univ., Fort Collings, Colo., 1971.

Edminster, F. C., American Game Birds of Field and Forest. Castle Books, New York, N. Y., 1954.

Einarsen, A. S., The Pronghorn Antelope and its Management. Wildl. Manage. Inst., Washington, D. C. 1948, p. 134-135.

Eisenbud, M. and H.G. Petrow, "Radioactivity in the Atmospheric Effluents of Power Plants That Use Fossil Fuels," Science, 1964, 144: 288-289.

Environmental Protection Agency, "National Emission Standard for Hazardous Air Pollutants," Federal Register April 6, 1973a, Volume 38, No. 66.

_______, "Compilation of Air Pollutant Emission Factors," EPA Publication AP-42 and supplements, April, 1973b.

_______, Evaluation of Air Pollution Dispersion Models, 1974. A report to Environmental Protection Agency. Contract 68-02-1085, July 1974.

________, Technical Support Document for Designation of Carbon, Emery, Wayne, Garfield, Kane, Washington, Uintah, Duchesne, Salt Lake, Davis, and Utah Counties in Utah as Air Quality Maintenance Area, August, 1974.

Erickson, A.J., Aids for Estimating Soil Properties Significant to Engineering Interpretations. U.S.D.A., 1973.

Faith, W. L. and A. A. Atkisson, Jr., Air Pollution, Wiley-Interscience Publishers, 1972, p. 8.

Five County Association of Governments, Five County Association of Governments -- Overview. April 29, 1974.

Flinn, J. E., and R. S. Reimers, "Development of Predictions of Future Pollution Problems." EPA 600/5-74-005, March, 1974.

Friel, Charles M., The Utah Jail Study. Sam Houston State University, Huntsville, Texas.

Frome, M., The Varmints - Our Unwanted Wildlife. Coward-McCann, 1969, p. 36-49.

Frydman, M. A. Levy, S. B. Miller, "Oxidant Measurements in the Vicinity of Energized 765 kv Lines." IBBB Journal, May-June 1973, 1141-1148.

Gates, D. H., Stoddard, L. A., and Cook, C. W., Soil as a Factor Influencing Plant Distribution on Salt Deposits of Utah. Ecological Monographs 26, 1956, Pages 155-175.

Gebhards, S., "The Vanishing Stream," Idaho Wildlife Review. March-April, 1970, 22:5.

Geiger, Rudolf, The Climate Near the Ground, Harvard University Press, Cambridge, Mass., 1961 (revised edition).

Geist, V., Mountain Sheep: A Study in Behavior and Evolution. The Univ. of Chicago Press, Chicago, Ill. 1971, p. 1-18 347-353.

Gier, H. T., Coyotes in Kansas. Agric. Exp. Sta., Kansas State Univ., Manhattan, Kan. 1968.

Graham, Edward H., Natural Principles of Land Use, Oxford University Press, London, New York, Toronto, 1944.

Gullion, G. W. and G. C. Christensen, "A Review of the Distribution of Gallinaceous Game Birds in Nevada." Nev. Fish and Game Comm., Austin and Reno, The Condor, 1956, 59:128-138.

________, Wildlife Uses of Nevada Plants. Paper No. 5140 Sci. J. Ser., Minn. Agric. Exp. Sta., Univ. of Minn., St. Paul Minn., 1964.

Hagihara, J. S., Rice, C. M., and Langan, L. N., Interim Guide for Rating Soils According to their Soil Suitability for Rangeland Seeding. Technical Note. Portland Service Center, 1972.

Hall, J. G., "The Kaibab Squirrel." Symposium on Rare and Endangered Wildlife of the Southwestern United States, N. Mexico Dept. of Game and Fish, Sante Fe, N.M. 1972, p. 18-21.

Hall, R. E., Mammals of Nevada. Univ. Calif. Press, Berkeley, Calif. 1946.

Hanna, Steven R., Meteorological Effects of Cooling Tower Plumes, U. S. Dept. of Commerce, NOAA, ATDL Contribution File No. 48, January 1971.

________, Meteorological Effects of the Cooling Towers at the Oak Ridge Gaseous Diffusion Plant, Part II: Predictions of Fog Occurrence and Drift Deposition, U. S. Dept. of Commerce, NOAA, ATDL Contribution File No. 88, March 1974.

__________, "Fog and Drift Deposition From Evaporation Cooling Towers," Nuclear Safety, 1974, 15: 190-196.

Hill, A. C., W. H. Edwards, T. W. Barrett, K. T. Harper, C. Leathers, M. Treskow, H. E. Price, Air Pollution Investigations in the Vicinity of the Four Corners and San Juan Power Plants, Utah, Engineering Experiment Station, University of Utah, March, 1973.

_________, W. H. Edwards, W. Ursenbach, "Air Pollution Investigations in the Vicinity of the Mohave Power Plant of the Southern California Edison Company." Report of the Utah Engineering Experiment Station, University of Utah, Salt Lake City, Utah, 1973.

______, W. O. Ursenbach, and N. DeNevers, Statement presented before the hearings on proposed regulations to prevent significant deterioration. September 5-6, 1973. Utah Engineering Experiment Station, University of Utah, Salt Lake City, Utah, 1973.

________, T. Barrett, S. Hill, C. Lamb, "Sensitivity of Nature Desert Vegetation to SO_2 and SO_2 and NO_2 Combined." APCA Journal, 1974, 24: (2) 153-157.

________, M. R. Pack, M. Treshaw, R. J. Downs, and L. G. Transtrum, "Plant Injury Induced by Ozone." Phytopathology 1961, 51: 356-363.

________, "Air Quality Standards for Fluoride Vegetation Effects," APCA Journ., 1969, Vol. 19, No. 5, Pages 331-336.

Hino M., "Maximum Ground Level Concentration and Sampling Time." Atmospheric Environment, 1968, 2: 149-165.

Hornocker, M. G., An Analysis of Mountain Lion Predation Upon Mule Deer and Elk in the Idaho Primitive Area. Wildl. Mono. No. 21, Wildl. Soc. Washington, D. C., 1970.

Hostler, C. L., J. Pena, and R. Pena., Determination of Salt Deposition Rates From Drift From Evaporation Cooling Towers. Dept. of Meteorology, Pennsylvania State University, University Park, Pa., May, 1972.

Institute for the Study of Outdoor Recreation and Tourism, Utah State University. Utah Resident Outdoor Recreation Participation Final Report, 1971-1972. Logan, Utah, 1973.

Intera Environmental Consultants, Ltd., "Model Simulation of Potential Air Quality Impact of the Kaiparowits Power Generating Station." Report prepared for Southern California Edison Co., July, 1974.

Johnsgard, P. A., Grouse and Quails of North America. Univ. of Neb., Lincoln, Neb. 1973.

Johnstone, H. F. and D. R. Coughanour, "Absorption of Sulfur Dioxide From Air and Oxidation in Drops Containing Dissolved Catalysts." Ind. Eng. Chem. 1958, 50: 1169-1172.

Joint Meteorological Report. Contributors were Dames and Moore, North American Weather Consultants, L. W. Crow, R. G. Larsen, and A. C. Hill. Second Edition September 1, 1971.

Kaakinen, J. W., R. M. Jorden, M. H. Lawasani, R. E. West, "Trace Element Behavior in a Coal-Fired Power Plant." Paper presented at the Symposium on Fractionation of Trace Elements in Coal-Fired Power Plants. American Chemical Society Meetings, April, 1975.

Kane County Board of Commissioners, Kaiparowits Power Project -- Status and Needs Report. Kane County, Utah, July 8, 1974.

Kearney, T. H. and R. H. Peebles, Arizona Flora, Second Edition, University of California Press, Berkeley, California, 1960.

King, N., Watershed Workshop in Vernal, Utah. Conducted by the Soil and Moisture Branch, Geologic Division, U.S.G.S., 1971.

Klein, D. H., A. W. Andreu, J. A. Carter, J. F. Emery, C. Feldmen, W. Fulkerson, W. S. Lyon, J. C. Ogle, Y. A. Talmi, R. I. Van Hook, and N. E. Bolton, "Trace Element Measurements at the Coal-Fired Allen Steam Plant: Mass Balance and Concentration in Fly Ash." Paper presented at the Symposium on Fractionation of Trace Elements in Coal-Fired Power Plants. American Chemical Society Meetings, April, 1975.

Kleinman, A. P., Barney, G. J., and Titmus, S. G., Economic Impacts of Changes on Salinity Levels of the Colorado River, U. S. Bureau of Reclamation, Denver, Colo., 1974.

Kochert, M. N., Population Status and Chemical Contamination in Golden Eagles in Southwestern Idaho. M. S. Thesis. Univ. of Idaho, Moscow, 1972.

Kohrs, ElDean V., Social Consequences of Boom Growth in Wyoming. Rocky Mountain American Association of the Advancement of Science, Laramie, Wyoming, April 24-26, 1974.

Kormondy, E. J., Concepts of Ecology. Prentice-Hall Biological Science Series. Englewood Cliffs, N. J., 1969.

Lane, Theodore, "The Urban Base Multiplier: An Evaluation of the Art," Land Economics. August 1966.

LaRivers, L., Fishes and Fisheries of Nevada. Nev. State Fish and Game Comm., Carson City, Nev., 1962.

Leopold Aldo, Game Management, Charles Scribner's Sons, New York, London 1946.

Lindsdale, J. M., Amphibians and Reptiles of Nevada. Univ. of Calif., Berkeley, Calif., 1938, p. 198-257.

Los Angeles Regional Planning Commission, Environmental Development Guide, October 1, 1970.

________, General Plan of Los Angeles County. April 1973.

Mackenthun, Kenneth M., and William Marcus Ingram, Biological Associated Problems in Fresh Water Environments, Federal Water Pollution Control Administration, July 1967.

Meteorology Research Inc., "Salt Deposition at the Kaiparowits Generating Station." Report to Southern California Edison, 1974.

Miholowsky, W. T. et al., The Regional Impact of Near-Term Transportation Alternatives: A Case Study of Los Angeles. The Rand Corporation, June, 1974.

Moen, Aaron N., Wildlife Ecology, W. H. Freeman and Company, San Francisco, 1973.

Montgomery, T. L, S. B. Carpenter, and H. E. Lundley, "The Relationship Between Peak and Mean SO_2 Concentrations." Symposium on air pollution meteorology. Raleigh N. C., April, 1971.

________, W. B. Norris, F. W. Thomas, and S. B. Carpenter, "A Simplified Technique Used to Evaluate Atmospheric Dispersion of Emissions From Large Power Plants." J. of Air Pollution Control Assn. 1973, 23: 388-394.

Nelsen, M. W., "The Status of the Peregrine Falcon in the Northwest." Peregrine Falcon Populations - Their Biology and Decline, edited by Joseph J. Hickey. Univ. Wisc. Press, Madison, Wisc., 1965, 4: 6-72.

Odum, E. P., Fundamentals of Ecology. W. B. Saunders Comp., Philadelphia, Penna., 1959.

______, Ecology. Modern Biology Series., New York, 1963.

Olendorff, R. R., "Eagles, Sheep and Powerlines," Colorado Outdoors. Colo. Dept. of Fish and Game, Denver, Colo., 1972, 1: 3-11.

Page, J. L. and D. J. Seibert., "Inventory of Golden Eagle Nests in Elko County Nev." Cal-Nev. Wildl. Trans. of the Western Sect. of the Wildl. Soc., 1973, p. 1-8.

Palmer, R. S., The Mammal Guide, Mammals of North America North of Mexico. Doubleday and Comp., Inc., Garden City, N. Y., 1954.

Peine, John Douglas, "Land Management for Recreation Use of Off-Road Vehicles," unpublished PhD. Dissertation, University of Arizona, Tucson, Arizona, 1972.

Plummer, P. A., D. R. Christensen and S. B. Monsen, Restoring Big Game Range in Utah. Forest Serv. Intermountain Forest and Range Exp. Sta., Ephraim, Utah, 1968.

Prenzlow, E. J., A Literature Review on Pronghorn Behavior. Spec. Rep. No. 3, Colo. Game, Fish and Parks Dept., Research Div., Denver, Colo., 1965.

Radian Corporation, "A Program to Model the Plume Opacity for the Kaiparowits Steam Electric Generating Station." Report to Southern California Edison Company, June 13, 1974.

Rawley, Edwin, V., Statistical Data Concerning Utah Hunting and Fishing License Buyers, Publication 72-4, Utah State Division of Wildlife Resources, 1972.

"Resource Data." Report by Southern California Edison Co., August 1974.

Rich, T. A. "Particles and Air Pollution." Aerosol Science, 1971, 2:185.

Richards, L. A., Diagnosis and Improvement of Saline and Alkali Soils. U.S.D.A., Agri. Handbook No. 60, 1954.

Richardson, Reed C., and Joseph S. Peery, Recreation in Utah, University of Utah, January 1966.

Riverside County, General Plan-Land Uses, Highways, and Recreation. Riverside, California, 1966.

Rogers, Andrei, Matrix Analysis of Interregional Population Growth and Distribution. University of California Press, Berkeley, Calif., 1968.

San Diego Comprehensive Planning Organization, Analysis of Existing Trends Regional Development Alternative. June 1973.

________, Analysis of the Controlled Trends Regional Development Alternative, April 1974.

________, An Open Space System for the San Diego Region, April 1972.

________, Analysis of Radial Corridors Regional Development Alternative. October 1973.

San Diego County Environmental Development Agency, San Diego County General Plan, 1990, April 1974.

Scherer, H. N., B. J. Ware and C. H. SH.H, "Gaseous Effluents Due to BHV Transmission Line Corona." IBBB Journal, May-June, 1973, 1043-1049.

Seibert, D. J. and J. L. Page, Inventory of Golden Eagle Nests in Elko County, Nev. Bureau of Land Management, 1973.

Shannon, L. J., Particle Pollutant System Study - Volume II. Fine Particle Emissions. Midwest Research Inst., Kansas City, Mo., NITS PB 203521, August 1971. p. 205.

Shown, L. M., Evaluation of a Method for Estimating Sediment Yield. U. S. Geol. Surv. Prof. Paper 700-B, 1970, Pages B245-B249.

Simpson, J. H., Report of Explorations Across the Great Basin of the Territory of Utah for a Direct Wagon-Route From Camp Floyd to Genoa, in Carson Valley, 1859. 518 pp., Illus. Govt. Print. Off. Washington, D. C., 1876.

Six County Economic Development District, Annual Report 1974.

Snow, C., Habitat Management Series for Endangered Species, American Peregrine Falcon and Arctic Peregrine Falcon, Report No. 1, U. S. Bureau of Land Management, 1972.

______, Habitat Management Series for Unique or Endangered Species, Golden Eagles, Aquila chrysaetos. Rept. No. 7, Bureau of Land Management, 1973.

________, Habitat Management Series for Unique or Endangered Species, Prairie Falcon, Falco mexicanus. Report No. 8, Bureau of Land Management, 1974.

Southern California Association of Governments, An Outdoor Recreation and Capital Improvement Program. September 1972.

Southern California Edison Company, Kaiparowits Transmission System Route Feasibility Study, Kaiparowits-Eldorado 500 kv Transmission Line. 1974.

________, "Salt Deposition From Cooling Towers, Kaiparowits Power Project," Letter from R. S. Currie to F. Snell, February 20, 1975.

Southern California Rapid Transit District, Power Requirements. (xerox), n.d.

______, A Public Transportation Improvement Program. March 1974.

________, Rapid Transit for Los Angeles: Summary Report of Consultants' Recommendations, July 1973.

_______, System Analysis and Methodology. (xerox), n.d.

_______, Transit for Los Angeles County. July 1974.

Southwest Energy Study, "U. S. Environmental Protection Agency Air Pollution Aspects." Appendix C-1, March 1972.

______, "Report of the Meteorology Workgroup." Appendix E, March, 1972.

_______, "U. S. Geological Survey." Appendix, March, 1972.

Spangler, T. C., A. J. Anderson, and E. L. Hovind, "A Smoke Tracer Plume Simulation Study at the Kaiparowits Power Generating Station During November, 1973." North American Weather Consultants Report No. 735-a to Southern California Edison Co., December, 1973.

______, J. F. Boatmen, A. J. Anderson, M. W. Edelstein, and E. L. Hovind, "Meteorological Tracer Study for the Evaluation of the Kaiparowits Plant Site." North American Weather Consultants Report No. 744-a to the Southern California Edison Company, July 1974.

Speltz, C. N. and H. E. McCann, Personal communication. U. S. Geological Survey, Salt Lake City, Utah, 1974.

Standiford, D. R., L. D. Potter, and D. E. Kidd, Mercury in the Lake Powell Ecosystem, Lake Powell Research Project Bulletin Number 1, June 1973, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, 1973.

State of California, Department of Transportation. 1973 Traffic Volumes on the California State Highway System. Sacramento, Calif., 1974.

State of Nevada Department of Highways, Annual Average Daily Traffic State of Nevada 1973, Carson City, Nevada, 1974.

State of Utah Department of Natural Resources, Outdoor Recreation Agency, Utah Outdoor Recreation Plan. Salt Lake City, Utah, April 1973.

Storer, T. I., General Zoology. McGraw-Hill Book Comp., New York, 1943.

Sundstrom, C., W. G. Hepworth, and K. L. Diem, Abundance, Distribution and Food Habits of the Pronghorn. Bull. No. 12, Wyoming Game and Fish Comm., 1973.

Swank, W. G., The Mule Deer in Arizona Chaparral. Wildl. Bull. No. 3, State of Ariz. Game and Fish Dept., Phoenix, Ariz., 1958.

Taylor, W. P., The Deer of North America, the Stackpole Co., Harrisburg, Pa. 1956.

Tompkins, Terrill, and Dean Blinn, Preliminary Report on Effects of Mercury and Lead on the Productivity of Several Lake Powell Planktonic Diatoms, Second Annual Report of Environmental Impact Studies of the Navajo and Kaiparowits Power Plants, Northern Arizona University, May 1973.

Trippensee, R. E., Wildlife Management, Upland Game and General Principles. McGraw-Hill Book Comp., N. Y., 1948, Vol. I.

________, Wildlife Management, Fur Bearers, Waterfowl, and Fish. McGraw-Hill New York, N. Y., 1953, Vol. II.

Tsukamoto, J. K. and W. J. Deibert., "A Preliminary Report of Nevada Pronghorn Antelope Food Habits During Aug. and Sept." Trans. Interstate Antelope Conf., 1968, 1917-13.

Turner, D. B. Workbook of Atmospheric Dispersion Estimates, Equation 3.1, page 5. Environmental Protection Agency, Office of Air Programs, Publication No. AP26, 1970.

University of Utah, Bureau of Economic and Business Research Center for Economic and Community Development, Utah Facts. Salt Lake City, Utah, 1973.

U. S. Department of Agriculture, Sevier River Basin, Appendix V, Soils, Erosion and Sedimentation, Sevier River Basin, Utah. U. S. Department of Agriculture, 1971, p. 114.

U. S. Department of Health, Education and Welfare, Air Quality Criteria for Particulate Matter AP-49, January 1969.

U. S. Dept. of the Interior, Bureau of Land Management, The Impact of Power Transmission Lines and Their Effect on the Southwest Environment, 1970.

________, Riverside District California, The Recreation Vehicle in California. Riverside, California, 1974.

U. S. Department of the Interior, Fish and Wildlife Service, Threatened Wildlife of the United States. Washington, D. C., 1973.

________, United States List of Endangered Fauna. Washington, D. C., 1974.

U. S. Geological Survey, Elemental Composition of Surfacial Materials in the Conterminous United States. U.S.G.S. Prof. Paper 574-D, 1971.

________, Water Resources Data for Arizona for 1968 through 1972; U. S. Geological Survey, Washington, D. C., 1968, 1969, 1970, 1971, 1972, Part 2.

Utah Division of Wildlife Resources, Utah Big Game Harvest - 1973, Publication #74-4, Salt Lake City, Utah, 1974.

Utah Foundation, Statistical Review of Government in Utah. 1974 Edition, Salt Lake City, Utah, March 1974.

Utah State Board of Education, Uniform Coding Manual for Utah School Districts. Salt Lake City, Utah, 1973.

Utah State Department of Highways, Traffic on Utah Highways 1973 Salt Lake City, Utah, April 1974.

Utah State Law Enforcement Planning Agency, A Case Against Crime -- State Plan. (1974-76 Multi-Year Comprehensive State Plan of the Utah Law Enforcement Planning Agency and 1974 Annual Action Program).

Utah State Road Commission, Office of Planning and Programming. Annual Program Report. March 1, 1974.

Walther, E. G., M. D. Williams, R. Cudney, W. Malm, "Air Quality in the Lake Powell Region." Lake Powell Research Project Bulletin No. 3, August, 1974.

Wayne, L. G., Letter to Bechtel Power Corporation from Pacific Environmental Services, Inc., November 9, 1973.

Weir, A. Jr., "Navajo/Mohave Test Modules Program. 170 mw Horizontal Module Summary Report, Operating History, January 16, 1974 to February 9, 1975." Report prepared by Research and Development, Southern California Edison Co., February, 1975.

________, J. M. Johnson, D. G. Jones, S. T. Carlile, "The Horizontal Cross Flow Scrubber," Manuscript of paper presented at the Flue-Gas Desulfurization Symposium, EPA, Atlanta, Georgia, November 4, 1974.

Wilkie, Jane and Everett Lee, Evaluation of Discontinuities in Regional Population Projections. Water Resources Research Center, University of Massachusetts, Amherst, Mass., June 1973.

Williams, M. D., and E. G. Walther. Theoretical Analysis of Air Quality: Impacts on the Lake Powell Region. Lake Powell Research Project, 1974.

Williamson, M. A., "Heloderma Suspectum." Symposium of Rare and Endangered Wildlife of the Southwestern United States. N. Mex. Dept. of Game and Fish, Sante Fe, N. M., 1972, p. 114-117.

Willie, John C. and Associates, Pre-Application Study for the Kaiparowits New Town Site in Kane County. Kane County Commission, Kanab, Utah, July 1972 (also, updated study - 1974).

Wilson, C. L. and W. E. Loomis, Botany. Holt, Rinehart and Winston, Inc., 1952.

Winstrom, G. K. and J. C. Ovard., Cooling Tower Drift-Measurement, Control and Environmental Effects. Ecodyne Corporation, San Rosa, California, 1973.

Woodward-Envicon, Inc., "Trace Element Study for Four Corners Power Generating Plant and Navajo Mine." Report to Arizona Public Service Company, August 9 1974.

Yoakum, J., "Bighorn Food Habit-Range Relationships in the Silver Peak Range, Nv." Desert Bighorn Council Trans., 1964, 8:95-99.

________, and W. P. Dasmann, Habitat Manipulations Practices. Wildl. Manage. Tech., The Wildl. Soc. Washington D. C., 1969, 14:173-231.

________, Pronghorn Antelope Habitat Requirements for Sagebrush Grassland Biome, 1972.

Young, S. P. and E. A. Goldman, The Puma Mysterious American Cat. Dover Publ. Inc., N. Y. N.Y., 1946, p. 27.

_______, and H. T. Jackson, The Clever Coyote. The Stackpole Comp., Harrisburg, Pa., 1951.

Zoller, W. H., E. S. Gladney, G. E. Gordon. "Elemental Fractionation in the Chalk Point Power Plant." Paper presented at the Symposium on Fractionation of Trace Elements in Coal-Fired Power Plants, American Chemical Society meetings, April, 1975.

BIBLIOGRAPHY

CHAPTER IV

Bechtel Power Corporation, "Environmental Engineering Studies and Particulate and Sulfur Dioxide Removal Study, Kaiparowits Generating Station." A report to Southern California Edison Company, 1974.

Carpenter, S.B., T.L. Montgomery, T.M. Leavitt, W.C. Colbaugh, F.W. Thomas, "Principal Plume Dispersion Models: TVA Power Plants," Journal of Air Pollution Control Assn. 1971, 21:491-495.

Southern California Edison Company, "Project Summary: Mohave Production Scrubber," A report by Southern California Edison Co., 1974.

_______, Resources Data, July 1974.

Weir, A. Jr., "Navajo/Mohave Test Modules Program. 170 mw Horizontal Module Summary Report, Generating History, Jan. 16, 1974 to Feb. 9, 1974," a report to Southern California California Edison Company, Febraury 1975.

_______, J.M. Johnson, D.G. Jones, S.T. Carlisle, "The Horizontal Cross Flow Scrubber," Manuscript of Paper Presented at the FlueGas Desulfurization Symposium, EPA, Atlanta, Georgia, Nov. 4, 1974.

BIBLIOGRAPHY

CHAPTER V

Bechtel Power Corporation, "Environmental Engineering Studies: Gaseous Effluent and Visibility Studies." A report to Southern California Edison Company, July 1974.

Environmental Protection Agency, Technical Support Document for Designation of Carbon, Emery, Wayne, Garfield, Kane, Washington, Uintah, Duchesne, Salt Lake, Davis, Utah Counties in Utah as Air Quality Maintenance Areas, August 1974.

Frydman, M.A. Levy, S.B. Miller, "Oxidant Measurements in the Vicinity of Energized 765 kv Lines." IBBB Journal, May-June, 1973, 1141-1148.

Hill, A.C., M.R. Pack, M. Treshaw, R.J. Downs and L.G. Transtrum, "Plant Injury Induced by Ozone." Phytopathology, 1961, 51: 356-363.

Scherer, H.N., B.J. Ware and C.H. Shih, "Gaseous Effluents Due to BHV Transmission Line Corona." IBBB Journal, May-June, 1973, 1043-1049.

Weir, A. Jr., "Navajo/Mohave Test Modules Program. 170 mw Horizontal Module Summary Report, Operating History, January 16, 1974 to February 9, 1975." Report prepared by Research and Development, Southern California Edison Co., February 1975.

______, J.M. Johnson, D.G. Jones, S.T. Carlisle, "The Horizontal Cross Flow Scrubber," Manuscript of Paper Presented at the Flue-Gas Desulfurization Symposium, EPA, Atlanta, Georgia, November 4, 1974.

BIBLIOGRAPHY

CHAPTER VI

Bernstein, L., *Salt Tolerance of Grasses and Forage Legumes*. U.S.D.A., Agricultural Information Bulletin No. 194, Washington, D.C., 1958.

Dames and Moore, "Meteorological Evaluation of the Nipple Bench Area, Kaiparowits Plant Site," *Kaiparowits Project Environmental Report*, Salt Lake City, Utah, 1973.

Gates, D.H., et al., *Soil as a Factor Influencing Plant Distribution on Salt Deposits of Utah*. Ecological Monographs 26, 1956, pages 155-175.

Hill, A.C., "Vegetation: A Sink for Atmospheric Pollutants." *APCA Journal*, 1971, 21:341-346.

Joint Meteorological Report. Contributors were Dames and Moore, North American Weather Consultants, L.W. Crow, R.G. Larsen, A.C. Hill, 1971.

Richards, L.A., *Diagnosis and Improvement of Saline and Alkali Soils*. U.S.D.A., Agricultural Handbook No. 60, 1954.

Standiford, D.R., L.D. Potter, D.E. Kidd, "Mercury in the Lake Powell Ecosystem." *Lake Powell Research Project Bulletin No. 1*, June 1973.

Southwest Energy Study, *Report of the Mining Work Group*, Appendix E, U.S. Dept. of the Interior, 1972.

U.S. Department of the Interior, *Report on Water for Energy in the Upper Colorado River Basin*, Water for Energy Management Team, Denver, Colorado, 1974.

Walther, E.G., et al., "Air Quality in the Lake Powell Region." *Lake Powell Research Project Bulletin No. 3*, August 1974.

CHAPTER VII

Health and Safety Analysis Center, *Personal Communication*, Mining Enforcement and Safety Administration, Denver Federal Center, Denver, Colorado, November 8, 1974.

United Mine Workers Journal, Washington, D.C., October 16-31, 1974.

BIBLIOGRAPHY

CHAPTER VIII

Air Pollution Control District, County of Los Angeles, Major Point Sources of Air Pollution in Los Angeles County. April, 1973.

Allred, D.M., Navajo Generation Station Ecological Baseline Study. Annual Report 6/1/71-6/1/72 BYU Press. Provo, Utah, 1972.

Arizona Commission of Agriculture and Horticulture, Arizona Native Plant Law, Arizona Revised Statutes, Chapter 7, 1972.

Arizona Highway Department, Arizona Traffic 1973. Phoenix, Arizona, 1974.

Atomic Energy Commission, "Concentrations in Air and Water above Natural Background." Code of Federal Regulations, Title 10, Part 20, Appendix B. November 5, 1973.

Bagley, J.M., Jeppson, R.W., and Milligan, C.H., Water Yields in Utah, Special Report 18, Utah State Agricultural Experiment Station, Utah State University, Logan, Utah, 1964.

Barnes, C.T., The Cougar or Mountain Lion, The Ralton Co., Salt Lake City, Utah 1960. p. 71-85.

Barrett, R.H., "Seasonal Food Habits of Bighorn at the Desert Game Range, Nev.," Desert Bighorn Council Trans. 1964, 8:85-93.

Baver, L.D., Soil Physics. John Wiley and Sons, Inc., New York, N.Y., 1959, Pages 227-234.

Beale, D.M., The Relationship of Range Conditions to Pronghorn Antelope Productivity and Survival, Utah State Dept. Fish and Game, Fed. Aid Job Completion Rept., Proj. No. W-105-R-2, 1966.

________and G.W. Scotter, "Seasonal Forage Use by Pronghorn Antelope in Western Utah." Utah Science, Agric. Exp. Sta., Logan, Utah, 1968, 29:1.

Bechtel Power Corporation, "Environmental Engineering Studies: Gaseous Effluent and Visibility Study." Report prepared for Southern California Edison Company, July, 1974a.

_______, "Environmental Engineering Studies and Cooling Tower Drift and Fogging Study for the Kaiparowits Generating Station." Report to Southern California Edison Co., June, 1974b.

________, "Environmental Engineering Studies: Particulate and Sulfur Dioxide Removal Study, Kaiparowits Generating Station." Report to Southern California Edison Co., July, 1974.

Bent, A.C., Life Histories of North American Birds of Prey, Dover Publ. Inc., N.Y. Rep. 1937. 1961, Part I.

_________, Life Histories of North American Birds of Prey, Dover Publ. Inc., N.Y. Rep. 1937. 1961, Part II.

_______, Life Histories of North American Gallinaceous Birds, Dover Publ. Inc., N. Y. rep. 1932. 1963, p. 40-43.

Berg, C. A., "Conservation in Industry," in Philip H. Abelson: Energy: Use, Conservation, and Supply. American Assoc. for the Advancement of Sci., Washington, D. C., 1974.

Bernstein, L., Salt Tolerance of Grasses and Forage Legumes. U.S.D.A., Agri. Info. Bull. No. 194, 1958.

Bond, F.M., "Falcons." Symposium on Rare and Endangered Wildlife of the Southwestern United States. N. Mex. Fish and Game Dept., 1972, p. 51-55.

"Boom Towns," High Country News. Lander, Wyoming, June 7, 1973.

Brauner, Gerhard, Subsidence Due to Underground Mining, in two parts. Part 1: Theory and Practices in Predicting Surface Deformation, Bureau of Mines, I.C. 8571, 1973, I-56.

Brigham Young University and Northern Arizona University, Environmental Studies of the Navajo and Kaiparowits Generation Stations. 1971-1974.

Brigham Young University, Center for Business and Economic Research, Kaiparowits Socio-Economic Study. Provo, Utah, February 1973.

Buechner, H.K., The Bighorn Sheep in the United States, Its Past, Present and Future. Wildl. Mono. No. 4 Wild. Soc., 1960.

Cain, D., The Ely Chain, Bureau of Land Management, Ely, Nev., 1971.

Calalane, V.H., Cougar, Grizzly, and Wolf in North America, N. Y. Zool. Soc., 1964.

California Air Resources Board, Oxidant Trends in the South Coast Air Basin, 1963-1972. April 1973.

________, Ten-Year Summary of California Air Quality Data, 1963-1972. January, 1974.

California Environmental Quality Study Council, Environmental Quality in California: A Strategy for Action. March 1972.

______, Progress Report. Feb. 1970.

California Federation of Mineralogical Societies, Data on Mineral Collection Areas and Popular Rockland Sites. 1964.

________, "Climatological Data Summary, Nipple Bench, Kane County, Utah." Report to Southern California Edison Co., Feb. 18, 1974.

California Native Plant Society, Inventory of Rare, Endangered, and Extinct Vascular Plants of California, 1972.

Call Engineering, Inc., Kaiparowits New Town, Environmental Impact Data, Call Engineering, Inc., Salt Lake City, Utah, 1974.

Carpenter, S.B., T.L. Montgomery, J.M. Leavitt, W.C. Colbaugh, F.W. Thomas, "Principal Plume Dispersion Models; TVA Power Plants." J. of Air Pollution Control Association, 1971, 21: 491-495.

Charlson, R.J., "Atmospheric Visibility Related to Aerosol Mass Concentration," Environmental Science and Technology, 1969, 3:913.

Coombs, E.M., Desert Tortoise, Gopherus agassizi, study progress report, summer 1973 in the Beaver Dam Wash area. Bureau of Land Management, Cedar City, Utah 1973.

Corn, M., "Nonviable Particles in the Air," In Stern, A.C. Air Pollution, Academic Press, Volume 1, p. 47.

Cummins, Arthur B. and Ivan A. Given, SME Mining Engineering Handbook, in two volumes, 1973, Vol. I, Sec. 13.1.

Dames and Moore, "Meteorological Evaluation of the Nipple Bench Area, Kaiparowits Plant Site," Kaiparowits Project Environmental Report, Salt Lake City, Utah, June 1973, Vol. II, Appendix D.

________, "Meteorological Monitoring Program, Nipple Bench and Fourmile Bench, Utah," Annual Report to Southern California Edison Co., Mar. 31, 1975.

Dasmann, R.F., Biomass, Yield and Economics Value of Wild and Domestic Ungulates Proc. Union Inter. Game Biologist. Bournemouth, England, 1964.

Dasmann, W., If Deer are to Survive. Wildl. Manage. Inst. Stackpole Books, Harrisburg, Penna., 1971.

Daubenmire, R., Plant Communities, a Textbook of Plant Synecology. Harper & Row Publishers, New York, 1968.

DeCalesta, D.S., A Literature Review of Cottontail Feeding Habits, Spec. Rep. No. 25, Colo. Div. of Game, Fish and Parks, Denver, Colo., 1971.

Division of Highways, Business and Transportation Agency, Department of Public Works, 1972 Traffic Volumes on the California State Highway System, Sacramento, California, 1973.

Drewien, G., Food Habits and Weight Relationships of Mourning Doves in Northern Nevada. M.S. Thesis, Univ. of Nev., 1971.

Dunaway, D.J., Human Disturbance as a Limiting Factor of Sierra Nevada Bighorn Sheep. First North American Wild Sheep Conference, April 14-15, Colo. State Univ., Fort Collings, Colo., 1971.

Edminster, F.C., American Game Birds of Field and Forest. Castle Books, New York, N. Y., 1954.

Einarsen, A.S., The Pronghorn Antelope and its Management. Wildl. Manage. Inst., Washington, D. C. 1948, p. 134-135.

Eisenbud, M. and H.G. Petrow, "Radioactivity in the Atmospheric Effluents of Power Plants that Use Fossil Fuels," Science, 1964, 144: 288-289.

Environmental Protection Agency, "National Emission Standard for Hazardous Air Pollutants," Federal Register April 6, 1973a, Volume 38, No. 66.

______, "Compilation of Air Pollutant Emission Factors," EPA Publication AP-42 and supplement, April, 1973b.

______, Evaluation of Air Pollution Dispersion Models, 1974. A report to Environmental Protection Agency. Contract 68-02-1085, July 1974.

______, Technical Support Document for Designation of Carbon, Emery, Wayne, Garfield, Kane, Washington, Uintah, Duchesne, Salt Lake, Davis, and Utah Counties in Utah as Air Quality Maintenance Area, August, 1974.

Erickson, A.J., Aids for Estimating Soil Properties Significant to Engineering Interpretations. U.S.D.A., 1973.

Faith, W.L. and A.A. Atkisson, Jr., Air Pollution, Wiley-Interscience Publishers, 1972, p. 8.

Federal Energy Administration, Project Independence Report. Federal Energy Administration, U.S. Govt. Printing Office, Washington D.C., 1974.

Five County Association of Governments, Five County Association of Governments--Overview. April 29, 1974.

Flinn, J.E., and R.S. Reimers, "Development of Predictions of Future Pollution Problems." EPA 600/5-74-005, March, 1974.

Freeman, S.D., A Time to Choose; America's Future. Final report by the Energy Policy Project of the Ford Foundation, Bullinger Pub. Co., 1974.

Freeman, W.N., Resources and Man. National Academy of Science-Research Council, Committee on Resources and Man, Washington, D.C., 1969.

Friel, Charles M., The Utah Jail Study. Sam Houston State University, Huntsville, Texas.

Frome, M., The Varmints - Our Unwanted Wildlife. Coward-McCann, 1969, p. 36-49.

Frydman, M.A. Levy, S.B. Miller, "Oxidant Measurements in the Vicinity of Energized 765 kv Lines." IBBB Journal, May-June 1973, 1141-1148.

Gates, D.H., Stoddard, L.A., and Cook, C.W., Soil as a Factor Influencing Plant Distribution on Salt Deposits of Utah. Ecological Monographs 26, 1956, Pages 155-175.

Gebhards, S., "The Vanishing Stream," Idaho Wildlife Review. March-April, 1970, 22:5.

Geiger, Rudolf, The Climate Near the Ground, Harvard University Press, Cambridge, Mass., 1961 (revised edition).

Geist. V., Mountain Sheep: A Study in Behavior and Evolution. The Univ. of Chicago Press, Chicago, Ill. 1971, p. 1-18, 347-353.

Gier, H.T., Coyotes in Kansas. Agric. Exp. Sta., Kansas State Univ., Manhattan, Kan. 1968.

Graham, Edward H., Natural Principles of Land Use, Oxford University Press, London, New York, Toronto, 1944.

Gullion, G.W., and G.C. Christensen, "A Review of the Distribution of Gallinaceous Game Birds in Nevada." Nev. Fish and Game Comm., Austin and Reno, The Condor, 1956, 59:128-138.

_______, Wildlife Uses of Nevada Plants. Paper No. 5140 Sci. J. Ser., Minn. Agric. Exp. Sta., Univ. of Minn., St. Paul Minn., 1964.

Hagihara, J.S., Rice, C.M., and Langan, L.M., Interim Guide for Rating Soils According to their Soil Suitability for Rangeland Seeding. Technical Note. Portland Service Center, 1972.

Hall, J.G., "The Kaibab Squirrel." Symposium on Rare and Endangered Wildlife of the Southwestern United States, N. Mexico Dept. of Game and Fish, Sante Fe, N.M. 1972, p. 18-21.

Hall, R.E., Mammals of Nevada. Univ. Calif. Press, Berkeley, Calif. 1946.

Hammond, A.L., "Individual Self-Sufficiency in Energy," in Philip H. Abelson: Energy: Use, Conservation, and Supply. American Assoc. for the Advancement of Sci., Washington, D.C., 1974.

Hanna, Steven R., Meteorological Effects of Cooling Tower Plumes, U.S. Dept. of Commerce, NOAA, ATDL Contribution File No. 48, January 1971.

_______, Meteorological Effects of the Cooling Towers at the Oak Ridge Gaseous Diffusion Plant, Part II: Predictions of Fog Occurrence and Drift Deposition, U.S. Dept. of Commerce, NOAA, ATDL Contribution File No. 88, March 1974.

_______, "Fog and Drift Deposition From Evaporation Cooling Towers," Nuclear Safety, 1974, 15: 190-196.

Hill, A.C., W.H. Edwards, T.W. Barrett, K.T. Harper, C. Leathers, M. Treskow, H.E. Price, Air Pollution Investigations in the Vicinity of the Four Corners and San Juan Power Plants, Utah, Engineering Experiment Station, University of Utah, March, 1973.

_______, W.H. Edwards, W. Ursenbach, "Air Pollution Investigations in the Vicinity of the Mohave Power Plant of the Southern California Edison Company." Report of the Utah Engineering Experiment Station, University of Utah, Salt Lake City, Utah, 1973.

_______, W.O. Ursenbach, and N. DeNevers, Statement presented before the hearings on proposed regulations to prevent significant deterioration. September 5-6, 1973. Utah Engineering Experiment Station, University of Utah, Salt Lake City, Utah, 1973.

______, T. Barrett, S. Hill, C. Lamb, "Sensitivity of Nature Desert Vegetation to SO_2 and SO_2 and NO_2 Combined." Journal, 1974, 24: (2) 153-157.

______, M.R. Pack, M. Treshaw, R.J. Downs, and L.G. Transtrum, "Plant Injury Induced by Ozone." Phytopathology 1961, 51: 356-363.

______, "Air Quality Standards for Fluoride Vegetation Effects," APCA Journ., 1969, Vol. 19, No. 5, Pages 331-336.

Hino M., "Maximum Ground Level Concentration and Sampling Time." Atmospheric Environment, 1968, 2: 149-165.

Hirst, Eric, and J.C. Mayers, "Efficiency of Energy Use in the Unites States," in Philip H. Abelson: Energy: Use, Conservation, and Supply. American Assoc. for the Advancement of Sci., Washington, D.C., 1974.

Hornocker, M.G., An Analysis of Mountain Lion Predation Upon Mule Deer and Elk in the Idaho Primitive Area. Wildl. Mono. No. 21, Wildl. Soc. Washington, D.C., 1970.

Hostler, C.L., J. Pena, and R. Pena., Determination of Salt Deposition Rates From Drift From Evaporation Cooling Towers. Dept. of Meteorology, Pennsylvania State University, University Park, Pa., May, 1972.

Hubbert, M.K., "Energy Resources" in Resources and Man, National Academy of Science-Research Council, Committee on Resources and Man, Washington, D.C., 1969.

Institute for the Study of Outdoor Recreation and Tourism, Utah State University. Utah Resident Outdoor Recreation Participation Final Report, 1971-1972. Logan, Utah, 1973.

Intera Environmental Consultants, Ltd., "Model Simulation of Potential Air Quality Impact of the Kaiparowits Power Generating Station." Report prepared for Southern California Edison Co., July, 1974.

Iron Resources of California, Bulletin 129, 1948.

Johnsgard, P.A., Grouse and Quails of North America. Univ. of Neb., Lincoln, Neb. 1973.

Johnstone, H.F., and D.R. Coughanour, "Absorption of Sulfur Dioxide From Air and Oxidation in Drops Containing Dissolved Catalysts." Ind. Eng. Chem. 1958, 50: 1169-1172.

Joint Meteorological Report. Contributors were Dames and Moore, North American Weather Consultants, L.W. Crow, R.G. Larsen, and A.C. Hill. Second Edition September 1, 1971.

Kaakinen, J.W., R.M. Jorden, M.H. Lawasani, R.E. West, "Trace Element Behavior in a Coal-Fired Power Plant." Paper presented at the Symposium on Fractionation of Trace Elements in Coal-Fired Power Plants. American Chemical Society Meetings, April, 1975.

Kane County Board of Commissioners, Kaiparowits Power Project -- Status and Needs Report. Kane County, Utah, July 8, 1974.

Kearney, T.H., and R.H. Peebles, Arizona Flora, Second Edition, University of California Press, Berkeley, California, 1960.

King, N., Watershed Workshop in Vernal, Utah. Conducted by the Soil and Moisture Branch, geologic Division, U.S.G.S., 1971.

Klein, D.H., A.W. Andreu, J.A. Carter, J.F. Emery, C. Feldmen, W. Fulkerson, W.S. Lyon, J.C. Ogle, Y.A. Talmi, R.I. Van Hook, and N.E. Bolton, "Trace Element Measurements at the Coal-Fired Allen Steam Plant: Mass Balance and Concentration in Fly Ash." Paper presented at the Symposium on Fractionation of Trace Elements in Coal-Fired Power Plants. American Chemical Society Meetings, April, 1975.

Kleinman, A.P., Barney, G.J., and Titmus, S.G., Economic Impacts of Changes on Salinity Levels of the Colorado River, U.S. Bureau of Reclamation, Denver, Colo., 1974.

Kochert, M.N., Population Status and Chemical Contamination in Golden Eagles in Southwestern Idaho. M.S. Thesis. Univ. of Idaho, Moscow, 1972.

Kohrs, ElDean V., Social Consequences of Boom Growth in Wyoming. Rocky Mountain American Association of the Advancement of Science, Laramie, Wyoming, April 24-26, 1974.

Kormondy, E.J., Concepts of Ecology. Prentice-Hall Biological Science Series. Englewood Cliffs, N.J., 1969.

Landsberg, Hans H., "Low-cost, Abundant Energy: Paradise Lost?", in Philip H. Abelson: Energy: Use, Conservation, and Supply. American Assoc. for the Advancement of Sci., Washington, D.C., 1974.

Lane, Theodore, "The Urban Base Multiplier: An Evaluation of the Art," Land Economics. August 1966.

LaRivers, L., Fishes and Fisheries of Nevada. Nev. State Fish and Game Comm., Carson City, Nev., 1962.

Leopold Aldo, Game Management, Charles Scribner's Sons, New York, London 1946.

Lincoln, G.A., "Energy Conservation," in Philip H. Abelson: Energy: Use, Conservation, and Supply. American Assoc. for the Advancement of Sci., Washington, D.C., 1974.

Lindsdale, J.M., Amphibians and Reptiles of Nevada. Univ. of Calif., Berkeley, Calif., 1938, p. 198-257.

Los Angeles Regional Planning Commission, Environmental Development Guide, October 1, 1970.

________, General Plan of Los Angeles County. April 1973.

Mackenthun, Kenneth M., and William Marcus Ingram, Biological Associated Problems in Fresh Water Environments, Federal Water Pollution Control Administration, July 1967.

Meteorology Research Inc., "Salt Deposition at the Kaiparowits Generating Station." Report to Southern California Edison, 1974.

Miholowsky, W.T., et al., The Regional Impact of Near-Term Transportation Alternatives: A Case Study of Los Angeles. The Rand Corporation, June, 1974.

Moen, Aaron N., Wildlife Ecology, W.H. Freeman and Company, San Francisco, 1973.

Montgomery, T.L., S.B. Carpenter, and H.E. Lundley, "The Relationship Between Peak and Mean SO_2 Concentrations." Symposium on air pollution meteorology. Raleigh N.C., April, 1971.

_______, W.B. Norris, F.W. Thomas, and S.B. Carpenter, "A Simplified Technique Used to Evaluate Atmospheric Dispersion of Emissions From Large Power Plants." J. of Air Pollution Control Assn. 1973, 23: 388-394.

Nelsen, M.W., "The Status of the Peregrine Falcon in the Northwest." Peregrine Falcon Populations - Their Biology and Decline, edited by Joseph J. Hickey. Univ. Wisc. Press, Madison, Wisc., 1965, 4: 6-72.

Odum, E.P., Fundamentals of Ecology. W.B. Saunders Comp., Philadelphia, Penna., 1959.

______, Ecology. Modern Biology Series., New York, 1963.

Olendorff, R.R., "Eagles, Sheep and Powerlines," Colorado Outdoors. Colo. Dept. of Fish and Game, Denver, Colo., 1972, 1: 3-11.

Page, J.L. and D.J. Seibert., "Inventory of Golden Eagle Nests in Elko County Nev." Cal-Nev. Wildl. Trans. of the Western Sect. of the Wildl. Soc., 1973, p. 1-8.

Palmer, R.S., The Mammal Guide, Mammals of North America North of Mexico. Doubleday and Comp., Inc., Garden City, N.Y., 1954.

Peabody Coal Company, Mining on Black Mesa, St. Louis, Missouri, November, 1970.

Peine, John Douglas, "Land Management for Recreation Use of Off-Road Vehicles," unpublished PhD. Dissertation, University of Arizona, Tucson, Arizona, 1972.

Plummer, P.A., D.R. Christensen and S.B. Monsen, Restoring Big Game Range in Utah. Forest Serv. Intermountain Forest and Range Exp. Sta., Ephraim, Utah, 1968.

Prenzlow, E.J., A Literature Review on Pronghorn Behavior. Spec. Rep. No. 3. Colo. Game, Fish and Parks Dept., Research Div., Denver, Colo., 1965.

Radian Corporation, "A Program to Model the Plume Opacity for the Kaiparowits Steam Electric Generating Station." Report to Southern California Edison Company, June 13, 1974.

Rawley, Edwin, V., Statistical Data Concerning Utah Hunting and Fishing License Buyers, Publication 72-4, Utah State Division of Wildlife Resources, 1972.

"Resource Data." Report by Southern California Edison Co., August, 1974.

Rich, T.A. "Particles and Air Pollution." Aerosol Science, 1971, 2:185.

Richards, L.A., Diagnosis and Improvement of Saline and Alkali Soils. U.S.D.A., Agri. Handbook No. 60, 1954.

Richardson, Reed C., and Joseph S. Peery, *Recreation in Utah*, University of Utah, January 1966.

Riverside County, *General Plan-Land Uses, Highways, and Recreation*. Riverside, California, 1966.

Rogers, Andrei, *Matrix Analysis of Interregional Population Growth and Distribution*. University of California Press, Berkeley, Calif., 1968.

San Diego Comprehensive Planning Organization, *Analysis of Existing Trends Regional Development Alternative*. June 1973.

________, *Analysis of the Controlled Trends Regional Development Alternative*. April 1974.

________, *An Open Space System for the San Diego Region*, April 1972.

________, *Analysis of Radial Corridors Regional Development Alternative*. October 1973.

San Diego County Environmental Development Agency, *San Diego County General Plan, 1990*, April 1974.

Scherer, H.N., B.J. Ware and C.H. SH.H, "Gaseous Effluenct Due to BHV Transmission Line Corona." *IBBB Journal*, May-June 1973, 1043-1049.

Seibert, D.J. and J.L. Page, *Inventory of Golden Eagle Nests in Elko County, Nev.* Bureau of Land Management, 1973.

Shannon, L.J., *Particle Pollutant System Study - Volume II.* Fine Particle Emissions. Midwest Research Inst., Kansas City, Mo., NITS PB 203521, August 1971. p. 205.

Shown, L.M., *Evaluation of a Method for Estimating Sediment Yield*. U.S. Geol. Surv. Prof. Paper 700-B, 1970, Pages B245-B249.

Simpson, J.H., *Report of Explorations Across the Great Basin of the Territory of Utah for a Direct Wagon-Route From Camp Floyd to Genoa, in Carson Valley, 1859*. 518 pp., Illus. Govt. Print. Off. Washington, D.C., 1876.

Six County Economic Development District, *Annual Report 1974*.

Snow, C., *Habitat Management Series for Endangered Species, American Peregrine Falcon and Arctic Peregrine Falcon*, Report No. 1, U.S. Bureau of Land Management, 1972.

________, *Habitat Management Series for Unique or Endangered Species, Golden Eagles, Aquila chrysaetos*. Rept. No. 7, Bureau of Land Management, 1973.

________, *Habitat Management Series for Unique or Endangered Species, Prairie Falcon, Falco mexicanus*. Report No. 8, Bureau of Land Management, 1974.

Southern California Association of Governments, *An Outdoor Recreation and Capital Improvement Program*. September 1972.

Southern California Edison Company, *Kaiparowits Transmission System Route Feasibility Study, Kaiparowits-Eldorado 500 kv Transmission Line*. 1974.

______, "Salt Deposition From Cooling Towers, Kaiparowits Power Project," Letter from R.S. Currie to F. Snell, February 20, 1975.

Southern California Rapid Transit District, Power Requirements. (xerox), n.d.

_______, A Public Transportation Improvement Program. March 1974.

_______, Rapid Transit for Los Angeles: Summary Report of Consultants' Recommendations, July 1973.

______, System Analysis and Methodology. (xerox), n.d.

______, Transit for Los Angeles County. July 1974.

Southwest Energy Study, "U.S. Environmental Protection Agency Air Pollution Aspects." Appendix C-1. March 1972.

________, "Report of the Meteorology Workgroup." Appendix E, March, 1972.

_______, "U.S. Geological Survey." Appendix, March, 1972.

Spangler, T.C., A.J. Anderson, and E.L. Hovind, "A Smoke Tracer Plume Simulation Study at the Kaiparowits Power Generating Station During November, 1973." North American Weather Consultants Report No. 745-a to Southern California Edison Co., December, 1973.

_____, J.F. Boatmen, A.J. Anderson, M.W. Edelstein, and E.L. Hovind, "Meteorological Tracer Study for the Evaluation of the Kaiparowits Plant Site." North American Weather Consultants Report No. 744-a to the Southern California Edison Company, July 1974.

Speltz, C.N. and H.E. McCann, Personal communication. U.S. Geological Survey, Salt Lake City, Utah, 1974.

Standiford, D.R., L.D. Potter, and D.E. Kidd, Mercury in the Lake Powell Ecosystem, Lake Powell Research Project Bulletin Number 1, June 1973, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, 1973.

State of California, Department of Transportation. 1973 Traffic Volumes on the California State Highway System. Sacramento, Calif., 1974.

State of Nevada Department of Highways, Annual Average Daily Traffic State of Nevada 1973, Carson City, Nevada, 1974.

State of Utah Department of Natural Resources, Outdoor Recreation Agency, Utah Outdoor Recreation Plan. Salt Lake City, Utah, April 1973.

Storer, T.I., General Zoology. McGraw-Hill Book Comp., New York, 1943.

Sundstrom, C., W.G. Hepworth, and K.L. Diem, Abundance, Distribution and Food Habits of the Pronghorn. Bull. No. 12, Wyoming Game and Fish Comm., 1973.

Swank, W.G., The Mule Deer in Arizona Chaparral. Wildl. Bull. No. 3, State of Ariz. Game and Fish Dept., Phoenix, Ariz., 1958.

Taylor, W.P., The Deer of North America, the Stackpole Co., Harrisburg, Pa. 1956.

Tompkins, Terrill, and Dean Blinn, Preliminary Report on Effects of Mercury and Lead on the Productivity of Several Lake Powell Planktonic Diatoms, Second Annual Report of Environmental Impact Studies of the Navajo and Kaiparowits Power Plants, Northern Arizona University, May 1973.

Trippensee, R.E., Wildlife Management, Upland Game and General Principles. McGraw-Hill Book Comp., N.Y., 1948, Vol. I.

______, Wildlife Management, Fur Bearers, Waterfowl, and Fish. McGraw-Hill New York, N.Y., 1953, Vol. II.

Tsukamoto, J.K, and W.J. Deibert., "A Preliminary Report of Nevada Pronghorn Antelope Food Habits During Aug. and Sept." Trans. Interstate Antelope Conf., 1968, 1917-13.

Turner, D.B., Workbook of Atmospheric Dispersion Estimates, Equation 3.1, page 5. Environmental Protection Agency, Office of Air Programs, Publication No. AP26. 1970.

University of Utah, Bureau of Economic and Business Research Center for Economic and Community Development, Utah Facts. Salt Lake City, Utah, 1973.

U.S. Bureau of Reclamation, "Wesco Gasification Project and Expansion of Navajo Mine by Utah International Inc.," Draft Environmental Statement. U.S. Bureau of Reclamation, Salt Lake City, Utah, 1974.

U.S. Department of Agriculture, Sevier River Basin, Appendix V, Soils, Erosion and Sedimentation, Sevier River Basin, Utah. U.S. Department of Agriculture, 1971, p. 114.

U.S. Department of Health, Education and Welfare, Air Quality Criteria for Particulate Matter AP-49, January 1969.

U.S. Dept. of the Interior, Bureau of Land Management, The Impact of Power Transmission Lines and Their Effect on the Southwest Environment, 1970.

_________, Bureau of Reclamation, Navajo Project Final Environmental Statement, 1972.

________, Riverside District California, The Recreation Vehicle in California. Riverside, California, 1974.

_________, Fish and Wildlife Service, Threatened Wildlife of the United States. Washington, D.C., 1973.

_________, United States List of Endangered Fauna. Washington, D.C., 1974.

U.S. Geological Survey, Elemental Composition of Surfacial Materials in the Conterminous United States. U.S.G.S. Prof. Paper 574-D, 1971.

_________, Water Resources Data for Arizona for 1968 through 1972, U.S. Geological Survey, Washington, D.C., 1968, 1969, 1970, 1971, 1972, Part 2.

Utah Division of Wildlife Resources, Utah Big Game Harvest - 1973. Publication #74-4, Salt Lake City, Utah, 1974.

Utah Foundation, Statistical Review of Government in Utah, 1974 Edition, Salt Lake City, Utah, March 1974.

Utah State Board of Education, Uniform Coding Manual for Utah School Districts. Salt Lake City, Utah, 1973.

Utah State Department of Highways, Traffic on Utah Highways 1973, Salt Lake City, Utah, April 1974.

Utah State Law Enforcement Planning Agency, A Case Against Crime -- State Plan. (1974-76 Multi-Year Comprehensive State Plan of the Utah Law Enforcement Planning Agency and 1974 Annual Action Program).

Utah State Road Commission, Office of Planning and Programming. Annual Program Report. March 1, 1974.

Walther, E.G., M.D. Williams, R. Cudney, W. Malm, "Air Quality in the Lake Powell Region." Lake Powell Research Project Bulletin No. 3, August, 1974.

Wayne, L.G., Letter to Bechtel Power Corporation from Pacific Environmental Services, Inc., November 9, 1973.

Weir, A. Jr., "Navajo/Mohave Test Modules Program. 170 mw Horizontal Module Summary Report, Operating History, January 16, 1974 to February 9, 1975." Report prepared by Research and Development, Southern California Edison Co., February, 1975.

________, J.M. Johnson, D.G. Jones, S.T. Carlile, "The Horizontal Cross Flow Scrubber," Manuscript of paper presented at the Flue-Gas Desulfurization Symposium, EPA, Atlanta, Georgia, November 4, 1974.

Wilkie, Jane and Everett Lee, Evaluation of Discontinuities in Regional Population Projections. Water Resources Research Center, University of Massachusetts, Amherst, Mass., June 1973.

Williams, M.D., and E.G. Walther. Theoretical Analysis of Air Quality: Impacts on the Lake Powell Region. Lake Powell Research Project, 1974.

Williamson, M.A., "Heloderma Suspectum." Symposium of Rare and Endangered Wildlife of the Southwestern United States. N. Mex. Dept. of Game and Fish, Sante Fe, N.M., 1972, p. 114-117.

Willie, John C. and Associates, Pre-Application Study for the Kaiparowits New Town Site in Kane County. Kane County Commission, Kanab, Utah, July 1972 (also, updated study - 1974).

Wilson, C.L. and W.E. Loomis., Botany. Holt, Rinehart and Winston, Inc., 1952.

Winstrom, G.K. and J.C. Ovard., Cooling Tower Drift-Measurement, Control and and Environmental Effects. Ecodyne Corporation, San Rosa, California, 1973.

Woodward-Envicon, Inc., "Trace Element Study for Four Corners Power Generating Plant and Navajo Mine." Report to Arizona Public Service Company, August 9, 1974.

Yoakum, J., "Bighorn Food Habit-Range Relationships in the Silver Peak Range, Nv." Desert Bighorn Council Trans., 1964, 8:95-99.

________, and W.P. Dasmann, Habitat Manipulations Practices. Wildl. Tech., The Wildl. Soc. Washington D.C., 1969, 14:173-231.

______, Pronghorn Antelope Habitat Requirements for Sagebrush Grassland Biome, 1972.

Young, S.P. and E.A. Goldman, The Puma Mysterious American Cat. Dover Publ. Inc., N.Y. N.Y., 1946, p. 27.

________, and H.T. Jackson, The Clever Coyote. The Stackpole Comp., Harrisburg, Pa., 1951.

Zoller, W.H., E.S. Gladney, G.E. Gordon. "Elemental Fractionation in the Chalk Point Power Plant." Paper presented at the Symposium on Fractionation of Trace Elements in Coal-Fired Power Plants, American Chemical Society meetings, April, 1975.

APPENDIX I-1

Federal Energy Administration Report

FEDERAL ENERGY ADMINISTRATION
WASHINGTON, D.C. 20461

UTAH STATE OFFICE

Rt	Off	Int	Date
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Action:
Info:
Discuss:

Mr. Frank Snell
Program Manager
E.I.S. Core Team/Kaiparowits
Utah State Office, Box 11505
Salt Lake City, Utah 84111

Dear Mr. Snell:

Enclosed is the Final Report of the Kaiparowits Project Energy Analysis which has been submitted to the Bureau of Land Management, Utah State Office, in conjunction with the Kaiparowits Environmental Impact Statement.

Your comments would be welcome.

Sincerely,

Donald B. Craven

Donald B Craven
Acting Assistant Administrator
Energy Resource Development

Enclosure

Final Report

Kaiparowits Project Energy Analysis

By
Robert L. Beck
Henry R. Myers

Office of Energy Resource Development

Federal Energy Administration

Washington, D. C. 20461

February 4, 1975

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Preface

This report concerns the proposed Kaiparowits Project, a 3000 megawatt coal-fired, baseload electric generating station to be constructed in Southern Utah. The discussion considers the need for Kaiparowits generating capacity and possible alternatives to the Kaiparowits Project in satisfying this need. This report also addresses briefly the use of energy and water resources, now destined for the Kaiparowits generating station, for purposes other than generation of electric power. Not considered are public policy options (e.g., restructuring of electric power rates or mandatory conservation) which would have a widespread impact on energy matters and, in so doing, affect the need for Kaiparowits and/or the merits of its alternatives.

The origin of this study was a request from the Bureau of Land Management (BLM) to the Federal Energy Administration (FEA). The BLM sought information which could be used in preparation of the "conservation alternatives" section of an Environmental Impact Statement being written in conjunction with the transfer of a power plant site from Federal ownership to the State of Utah. The FEA, in furtherance of its effort to stimulate more comprehensive energy discussion in Environmental Impact Statements, undertook to provide the requested information on conservation alternatives and, in addition, to prepare an analysis which would include discussion of the need for additional capacity and the alternatives to the construction of a coal-fired plant. In this regard, it is also intended to provide a base for future FEA efforts in regard to the electric power supply in the Southwestern United States. Since it is intended to provide energy background for preparation of the Environmental Impact Statement, environmental impacts of Kaiparowits and its alternatives are mentioned only in passing.

The following discussion is based on information provided by participating utilities, the BLM, the California Public Utilities Commission, the Arizona Corporation Commission, RAND Corporation, and others.

A general description of the Kaiparowits Project is presented in Section I. Section II considers electric power demand forecasts and presents rationales for the Kaiparowits Project. Section III discusses conceptual alternatives to the proposed project. Section IV concerns alternative uses of the energy resources which would be required by Kaiparowits. Conclusions are presented in Section V.

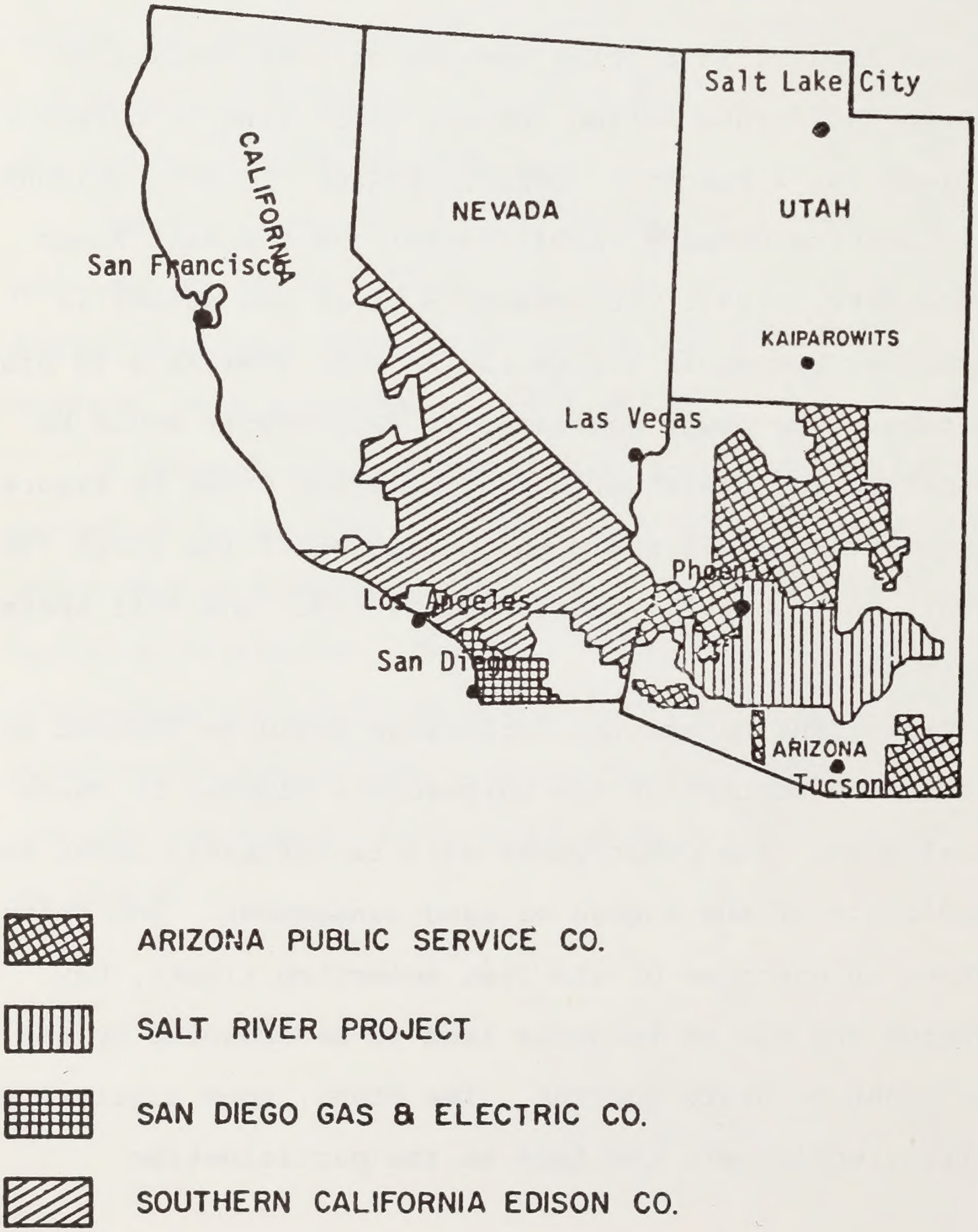
I. Introduction

The Kaiparowits Project plan provides for construction and operation of a 3,000 megawatt steam power electric generating station, associated transmission facilities, and underground coal mines. The latter would supply nine million tons of coal per year required for production of steam.

The Project is a joint venture of four utilities: Southern California Edison Company (SCE) (40% of output,), San Diego Gas & Electric Company (SDG&E) (23.4%), Arizona Public Service Company (APS) (18.0%) and the Salt River Project (SRP) (10%). At present 8.6% of the output is uncommitted but would ultimately be made available to other utilities. The power generated by Kaiparowits would be transmitted for distribution in the areas shown in Figure 1. The present schedule envisions operation of the first 750 megawatt unit in 1980, the second in 1981, and full operation in 1982.

Mining and generating facilities would be located on the southern portion of the Kaiparowits Plateau in South Central Utah. The power plant site is currently under the jurisdiction of the Bureau of Land Management. The State of Utah, in exercise of its lieu selection rights, has requested the BLM to transfer land to be occupied by the power plant to State control. The State, upon acquisition of title, would sell the land to the participating

KAIPAROWITS PROJECT PARTICIPANTS SERVICE TERRITORIES



utilities. The Kaiparowits participants have purchased coal leases on 46,000 acres of Federal and State lands in the plant's vicinity.

Each year, approximately 45,000 acre feet from Utah's allotment* of Colorado River water would be used for condenser cooling purposes when the plant was operating at a 3000 Mw power level. This is the quantity of water lost through evaporation from wet cooling towers and represents approximately 2% of the total flow through the towers. In addition, approximately 7,000 acre feet per year would be required for other activities associated with the Project. The water would be pumped approximately 30 miles from Lake Powell to storage reservoirs at the plant site.

The plant is designed to meet primary and secondary air quality standards under the Clean Air Act and State Implementation Plans. However, there may be a problem in meeting the "nondegradation" standard of the Clean Air Act. Whether such a problem materializes will depend upon the outcome of environmental litigation (e.g. Sierra Club v. EPA) and possible Congressional legislative action.

The owner-companies have determined that there is a need for a power plant the size and type of Kaiparowits in order to meet projected demand for baseload capacity and to decrease utilization of oil and natural gas as a boiler fuel. If demand forecasts were to be reduced substantially, Kaiparowits would still be proposed for construction at an adjusted schedule. Because Kaiparowits output could replace power provided by presently operating oil burning plants and thus displace 80,000 barrels of oil per day, the proposed project would, even in the event of zero growth in electric power demand, reduce United States dependence upon imported oil.

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*The participating utilities have contractual agreements with the State of Utah and the Department of the Interior which permits use of up to 102,000 acre feet per year for activities related to electric power generation. This amount was based upon original plans that Kaiparowits generating capacity would eventually be at a power level of 6000 Mw.

II. Need for the Kaiparowits Project

The utilities' decision to undertake the project under the proposed time schedule was based on a determination that new capacity was required in order to maintain system reliability in light of projected demand. The 3,000 megawatts of generating capacity installed at the Kaiparowits Plateau would comprise approximately 28% of the new capacity added to the combined generating capacity of these four utilities. The remainder of this section addresses (a) electric power demand forecasts upon which the utilities base their plans for new capacity and (b) rationales for satisfying projected demand through construction of a 3,000 megawatt coal-fired generation station.

A. Demand Forecasts

Because so many intangibles are involved in the process of forecasting electric power demand, there is wide diversity of conclusions regarding the level of future demand. As a result, demand forecasts are often disputed.

Many who believe growth in energy consumption must be slowed, maintain that utilities overestimate future demand in their forecasts, that forecasts are self-fulfilling, and therefore, more generating capacity is installed and more energy consumed than is necessary to satisfy a "reasonable" level of public need. In response, utilities contend that forecasts are not self-fulfilling that they are based on empirical and well-founded assumptions concerning growth of electric power demand.

In addition, utilities say that it is in their self-interest to make accurate demand forecasts. They point on the one hand to their responsibility to have capacity sufficient to provide adequate service, and on the other hand to the economic penalties of installing excess capacity. In rejecting the contention that demand forecasts are inflated and self-fulfilling, utilities note the difficulty of financing new facilities and the increasing costs of new generating capacity.

Nevertheless, given the fact that utility demand forecasts are contested, independent predictions of future demand would be useful in assessments of the need for new generating facilities. But no such comprehensive projections have been made for the Kaiparowits market area. Those projections which have been made either are insufficiently detailed or rest on assumptions considered too spectulative as a basis for planning. Therefore, the demand forecasts presented herein are those compiled by the Kaiparowits participants.*

---

*Primary assumptions made by each of the Kaiparowits participants in arriving at its current demand forecast and its capacity requirement are listed in Appendix A.

While the utilities' forecasts were accepted for purposes of this report as the best available, deviations from these rates of growth might occur. Improved economic conditions, lower fuel prices, or unanticipated uses could bring about increased demand. More stringent government regulation of electric power use, higher fuel prices, or expanded conservation efforts by consumers could result in a reduced demand. Changes in the 1974 demand forecasts with respect to those made in 1973 prior to the oil embargo demonstrate the sensitivity of forecasts to events which seem speculative one year but materialize the next.*

Forecasts and historical data are presented in the following tables and graphs.

Tables I, II, III and IV indicate respectively for APS, SRP, SDG&E and SCE the following types of data for the years indicated.

1. Market area population
2. 1973 forecast of peak demand
3. 1974 forecast of peak demand
4. Planned generating capacity
5. Generating reserve margins
6. 1973 forecast of energy requirements

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*In comparison to 1973 estimates, 1974 forecasts for peak demand in 1985 have been reduced approximately 22% by San Diego Gas & Electric, 19% by Southern California Edison, 0.3% by Arizona Public Service and 3.9% by the Salt River Project. Energy conservation policies of the Kaiparowits participants are listed in Appendix A.

7. 1974 forecast of energy requirements
8. Kw generating capacity per capita
9. Kw hours generated per capita

Figure 2 (APS), Figure 3 (SRP), Figure 4 (SDG&E), Figure 5 (SCE) and Figure 6 (sum of Kaiparowits participants) contain several types of data:

1. Historical peak demand through 1973
2. 1973 utility forecasts of peak demand (1974-85)
3. 1974 utility forecasts of peak demand (1974-85)
4. Peak demand 1974-1985 at annual growth rates ranging from 3% to 9%. The purpose of these curves is to show what generating capacities would be required if growth rates were to differ from those now projected by the utilities.
5. Generating capacities (step curves)

Figure 7 shows peak demand as a function of growth rate for the Kaiparowits market areas.

Figure 8 shows APS energy generated by fuel type for years 1963-1984.

Figure 9 shows SRP energy generated by fuel type for years 1960-1985.

Figure 10 shows SDG&E energy generated by fuel type for years 1960-1985

Figure 11 shows SCE energy generated by fuel type for years 1960-1984.

Arizona Public Service (Table I)*

	Year	Population (Thousands)	1973 Forecast Of Peak Demand (Megawatts)	1974 Forecast Of Peak Demand (Megawatts)	Planned Gen. Capacity (Megawatts)	Generating Reserve Margin(1) (%)	1973 Forecast Energy Requirements (10^6 kwhr)	1974 Forecast Energy Requirements (10^6 kwhr)	Load Factor(1) (%)	Kilowatt Gen. Capacity/ Capita(1)	Kilowatt hrs. Per Capita(1)
HISTORICAL	1955	469		359	483	34.5		1744	55.5	1.03	3719
	60	578		651	836	28.4		3288	57.5	1.45	5689
	65	678		817	1413	72.9		4214	58.9	2.08	6215
	1970	727		1273	1655	30.0		5918	53.1	2.28	8140
	71	761		1407	1698	20.7		6752	54.8	2.23	8873
	72	791		1659	2085	25.7		7938	54.5	2.64	10035
	73	821		1811	2191	21.0	8427	8888	56.0	2.66	10826
	74	856	2042	1962	2477	26.2	10271	9574	55.7	2.89	11185
	1975	896	2286	2169	2598	19.8	11272	10926	57.5	2.90	12194
	76	930	2542	2410	2884	19.7	12655	12593	59.5	3.10	13541
	77	967	2471	2638	3148	19.5	13588	14257	61.8	3.26	14744
	78	1007	2965	2838	3415	20.3	14688	15503	62.4	3.39	15395
	79	1047	3184	3091	3781	22.3	15683	16805	62.1	3.61	16051
	1980	1090	3415	3361	4051	20.5	16697	18322	62.1	3.72	16809
	81	1128	3653	3637	4542	24.9	17740	19817	62.2	4.03	17568
	82	1169	3920	3903	4692	20.2	18973	21072	61.6	4.01	18026
	83	1208	4197	4182	5200	24.3	20112	22418	61.2	4.30	18558
	84	1247		4480	5572	24.4		23630	60.1	4.47	18949
	85	1270		4838	5768	19.2		25429	60.0	4.54	20023
	Average Annual Compound Growth Rates (%)										
	1960-65	3.2		4.6	11.1			5.1		7.5	1.8
	1965-70	1.4		9.3	3.2			7.0		1.9	5.5
	1970-75	4.3		11.2	9.4			13.0		4.9	8.4
	1975-80	4.0	8.4	9.1	9.3			10.9		5.1	4.4
	1980-85	3.1		7.6	7.3			6.8		4.1	3.6

*Arizona Public buys power and energy from Salt River Project. This power and energy is included in the historical and projected figures.

In years 1955-1973, all data is historical. In years 1974-1985, all data is projected.

(1) Based on historical data for years 1955-1973 or on 1974 forecast for years 1974-1985.

Salt River Project (Table II)*

Year		Population (Thousands)	1973 Forecast Of Peak Demand (Megawatts)	1974 Forecast Of Peak Demand (Megawatts)	Planned Gen. Capacity (Megawatts)	Generating Reserve Margin(1) (%)	1973 Forecast Energy Requirements (10^6 kwhr)	1974 Forecast Energy Requirements (10^6 kwhr)	Load Factor(1) (%)	Kilowatt Gen. Capacity/ Capita(1)	Kilowatt hrs. Per Capita(1)
1955	HISTORICAL	240		254	284	11.8		1290		1.18	5375
60		318		479	505	5.4		2706	64.4	1.59	8509
65		420		727	912	25.4		3030	47.5	2.17	7214
1970		491		1207	1379	14.2		5256	49.7	2.81	10705
71				1276	1454	13.9		6388	57.1		
72				1533	1681	9.6		6679	49.7		
73		601		1679	1881	12.0		7552	51.3	3.13	12566
74		630	1991	1921	2271	18.2	9235	8718	51.8	3.60	13838
1975		658	2197	2121	2610	23.0	10076	9869	53.1	3.97	14998
76		682	2406	2325	2800	20.4	10500	10440	51.2	4.11	15308
77		708	2591	2531	2932	15.8	11212	11335	51.1	4.14	16010
78		737	2849	2734	3255	19.0	12404	12350	51.5	4.42	16757
79		760	3050	2944	3715	26.1	13172	13295	51.5	4.89	17493
1980		789	3237	3150	3790	20.3	13914	14157	51.3	4.80	17943
81		815	3484	3359	4222	25.6	14723	14876	50.5	5.18	18253
82		843	3752	3604	4222	17.1	15708	15824	50.1	5.01	18771
83		870	4009	3842	4547	18.3	16558	16675	49.5	5.23	19167
84		896	4261	4089	4904	19.9	17316	17564	49.0	5.47	19603
1985		913	4517	4343	5254	20.9	18271	18617	48.9	5.75	20391
Average Annual Compound Growth Rates (%)											
1960-65		5.7		8.7	12.5			2.3		6.4	-3.4
1965-70		3.2		10.7	8.6			11.6		5.3	8.2
1970-75		6.0		12.0	13.6			13.5		7.2	7.0
1975-80		3.7	8.1	8.2	7.7			7.5		3.9	3.7
1980-85		3.0	6.9	6.6	6.9			5.6		3.7	2.6

*The Salt River Project provides power and energy for resale to Arizona Public Service Company. This power and energy is included in the historical and projected figures.

In years 1955-1973, all data is historical. In years 1974-1985, all data is projected.

(1) Based on historical data for years 1955-1973 or on 1974 forecast for years 1974-1985.

San Diego Gas & Electric (Table III)*

Year	Population (Thousands)	1973 Forecast Of Peak Demand (Megawatts)	1974 Forecast Of Peak Demand (Megawatts)	Planned Gen. Capacity (Megawatts)	Generating Reserve Margin(1)(2) (%)	1973 Forecast Energy Requirements (10^6 kwhr)	1974 Forecast Energy Requirements (10^6 kwhr)	Load Factor(1) (%)	Kilowatt Gen. Capacity/ Capita(1)	Kilowatt hrs. Per Capita(1)
1955										
60	1050		670	769	14.8		2835	48.3	0.73	2700
65	1150		900	1166	29.6		3976	50.4	1.01	3457
1970	1350		1330	1519	14.2		5967	51.2	1.13	4420
71			1495	1719	15.0		6586	50.3		
72			1610	1846	14.7		7417	52.6		
73			1495	2130	42.5	8707	7652	58.4		
74	1528	2000	1612	2036	31.5	9663	8191	58.0	1.33	5360
1975	1564	2100	1764	2236	34.5	10933	9250	59.8	1.43	5914
76	1600	2250	1914	2254	20.7	12183	10216	61.0	1.41	6385
77	1640	2500	2077	2550	20.8	13246	11099	61.0	1.55	6768
78	1710	2700	2253	2550	19.8	14358	12124	61.4	1.49	7090
79	1750	2875	2436	2954	19.6	15566	13097	61.4	1.69	7474
1980	1790	3250	2633	3358	32.0	16979	14116	61.2	1.88	7886
81	1800	3460	2805	3761	28.0	18431	15041	61.2	2.09	8356
82	1860	3790	2988	4112	33.0	20069	16013	61.2	2.21	8609
83	1900	4000	3153	4112	29.0	20800	17107	62.0	2.16	9004
84	1950	4375	3319	4147	21.0	22400	18107	62.3	2.13	9286
1985	2000	4600	3612	4952	32.0	24200	19107	60.4	2.48	9554
Average Annual Compound Growth Rates (%)										
1960-65	1.8		6.1	8.7			7.0		6.7	5.1
1965-70	3.2		8.1	5.4			8.5		2.3	5.1
1970-75	3.0		5.8	8.0			9.2		4.8	6.0
1975-80	2.7	9.1	8.3	8.4			8.8		5.6	5.9
1980-85	2.7	7.2	6.5	8.1			6.2		5.7	3.9

*In years 1955-1973, all data is historical. In years 1974-1985, all data is projected.

(1) Based on historical data for years 1955-1973 or on 1974 forecast for years 1974-1985.
(2) Calculated at time of peak demand.

Southern California Edison Company (Table IV)*

Year		Population (Thousands)	1973 Forecast Of Area(2) Peak Demand (Megawatts)	1974 Forecast Of Area(2) Peak Demand (Megawatts)	Planned Gen. Capacity(3) (Megawatts)	Generating Reserve(1) Margin(2)(3) (%)	1973 Forecast Of Area Energy Require-ments (10^6 kwhr)	1974 Forecast Of Area Energy Require-ments (10^6 kwhr)	Area Load(1) Factor(2) (%)	Kilowatt Gen.(1) Capacity/ Capita(2)	Kilowatt hrs(1) Per Capita(2)
1955	HISTORICAL	4308		2454	2778	13.2		13404	62.4	0.65	3111
60		5406		3972	4619	16.3		21136	60.7	.85	3910
65		6581		6120	7088	15.8		33011	61.6	1.08	5016
1970		7230		8556	11129	30.1		49419	65.9	1.54	6835
71		7319		9897	12913	30.5		52667	60.7	1.76	7196
72		7403		10317	12913	25.2		55560	61.5	1.74	7505
73		7508		10535	13733	30.4	60188	58144	63.0	1.83	7744
74		7619	11365	11005	13704	24.5	64582	59384	61.6	1.80	7794
1975		7739	12217	11485	13887	20.9	69194	60650	60.3	1.79	7837
76		7867	13050	11995	14472	20.7	74295	61491	58.5	1.84	7816
77		7997	13903	12595	14733	17.0	79342	62526	56.7	1.84	7819
78		8129	14766	13265	15677	18.2	84727	67240	57.9	1.93	8272
79		8263	15689	13812	16411	18.8	90328	71919	59.4	1.99	8704
1980		8398	16683	14381	17092	18.9	96148	76927	61.1	2.04	9160
81		8536	17686	14961	18314	22.4	102177	82211	62.7	2.15	9631
82		8675	18718	15574	19287	23.8	108657	87721	64.3	2.22	10112
83		8817	19832	16278	19578	20.3	115408	93554	65.6	2.22	10611
84		8916	20956	17105	20629	20.6	121955	98948	66.0	2.31	11098
1985		9099	22123	18123	22039	21.6	128835	105027	66.2	2.42	11543
					Average Annual Compound Growth Rates (%)						
1960-65		4.0	9.0	9.0	8.9		9.3	9.3		4.9	5.1
1965-70		1.9	6.9	6.9	9.4		8.4	8.4		7.4	6.4
1970-75		1.4	7.4	6.1	4.5		7.0	4.2		3.1	2.8
1975-80		1.6	6.4	4.6	4.2		6.8	4.9		2.6	3.2
1980-85		1.6	5.8	4.7	5.2		6.0	6.4		3.8	4.7

*In years 1955-1973, all data is historical. In years 1974-1985, all data is projected.

(1) Based on historical data in years 1955-1973 or on 1974 forecast in years 1974-1985.
(2) Area demand = Edison's net main system and firm contractual sales.
(3) At time of system peak demand.

FIGURE 2

ARIZONA PUBLIC SERVICE COMPANY
(PEAK DEMAND VS. YEAR)
(GENERATING CAPACITY VS. YR.)

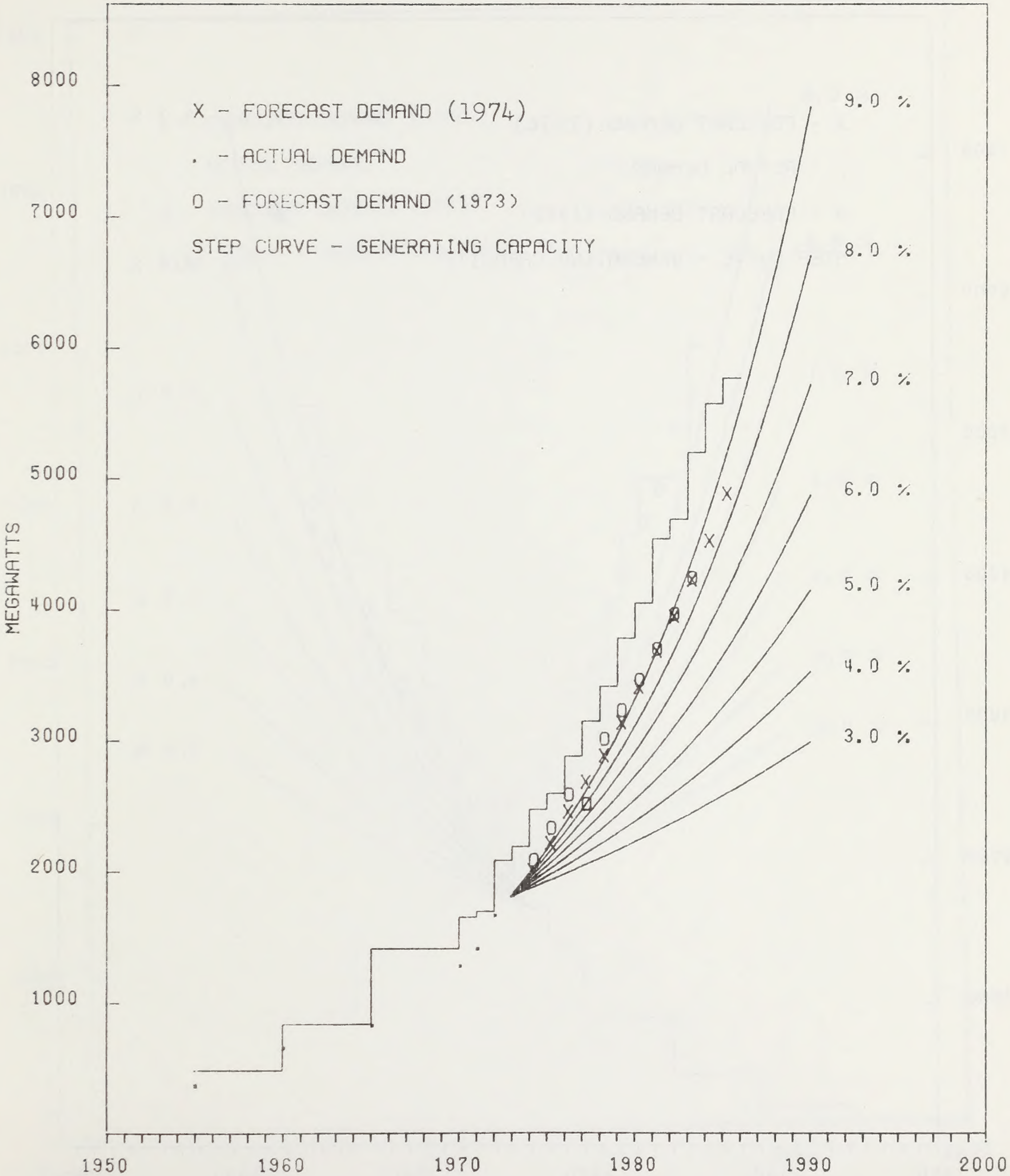


FIGURE 3

SALT RIVER PROJECT
(PEAK DEMAND VS. YEAR)
(GENERATING CAPACITY VS. YR.)

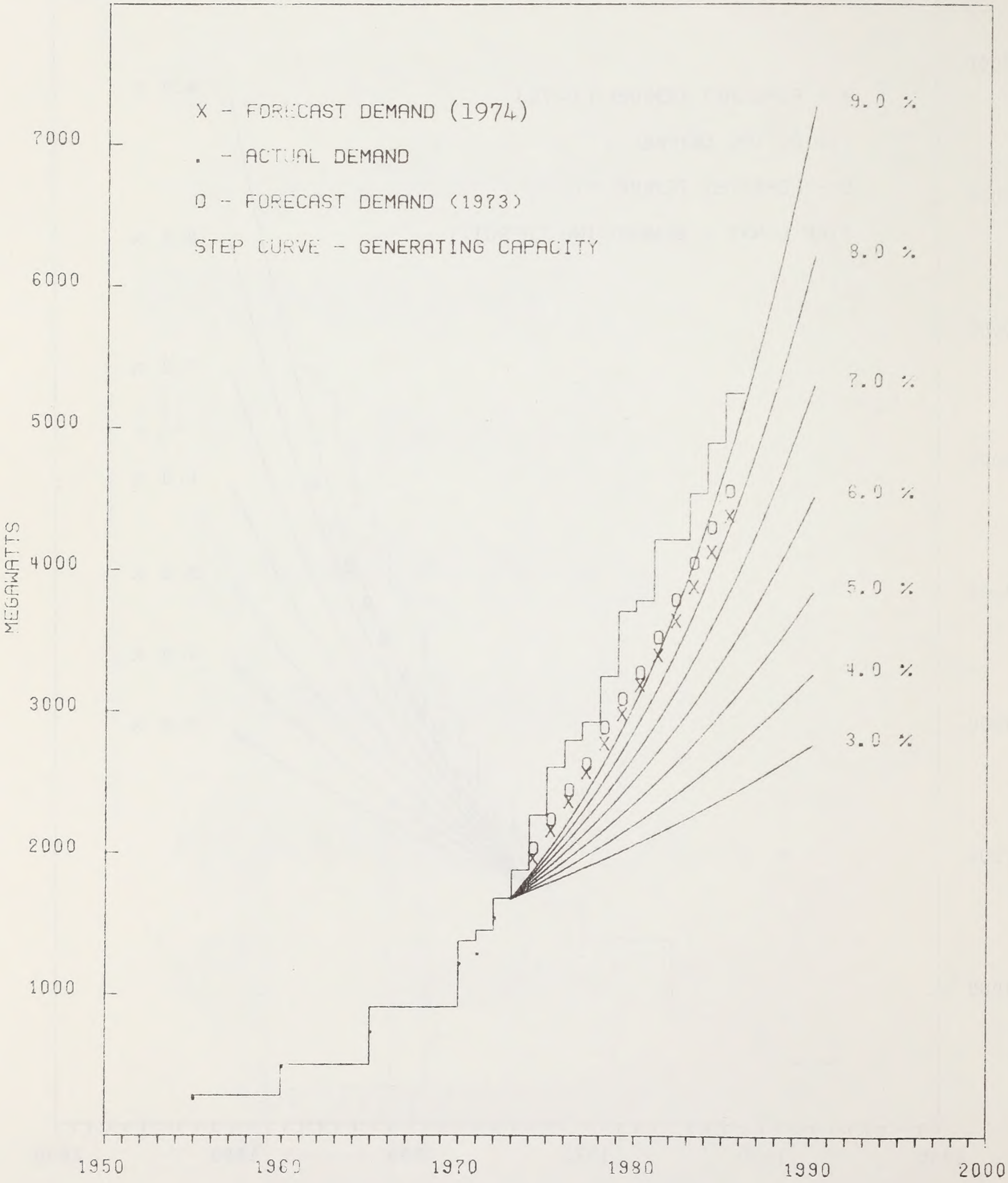


FIGURE 4

SAN DIEGO GAS AND ELECTRIC
(PEAK DEMAND VS. YEAR)
(GENERATING CAPACITY VS. YR.)

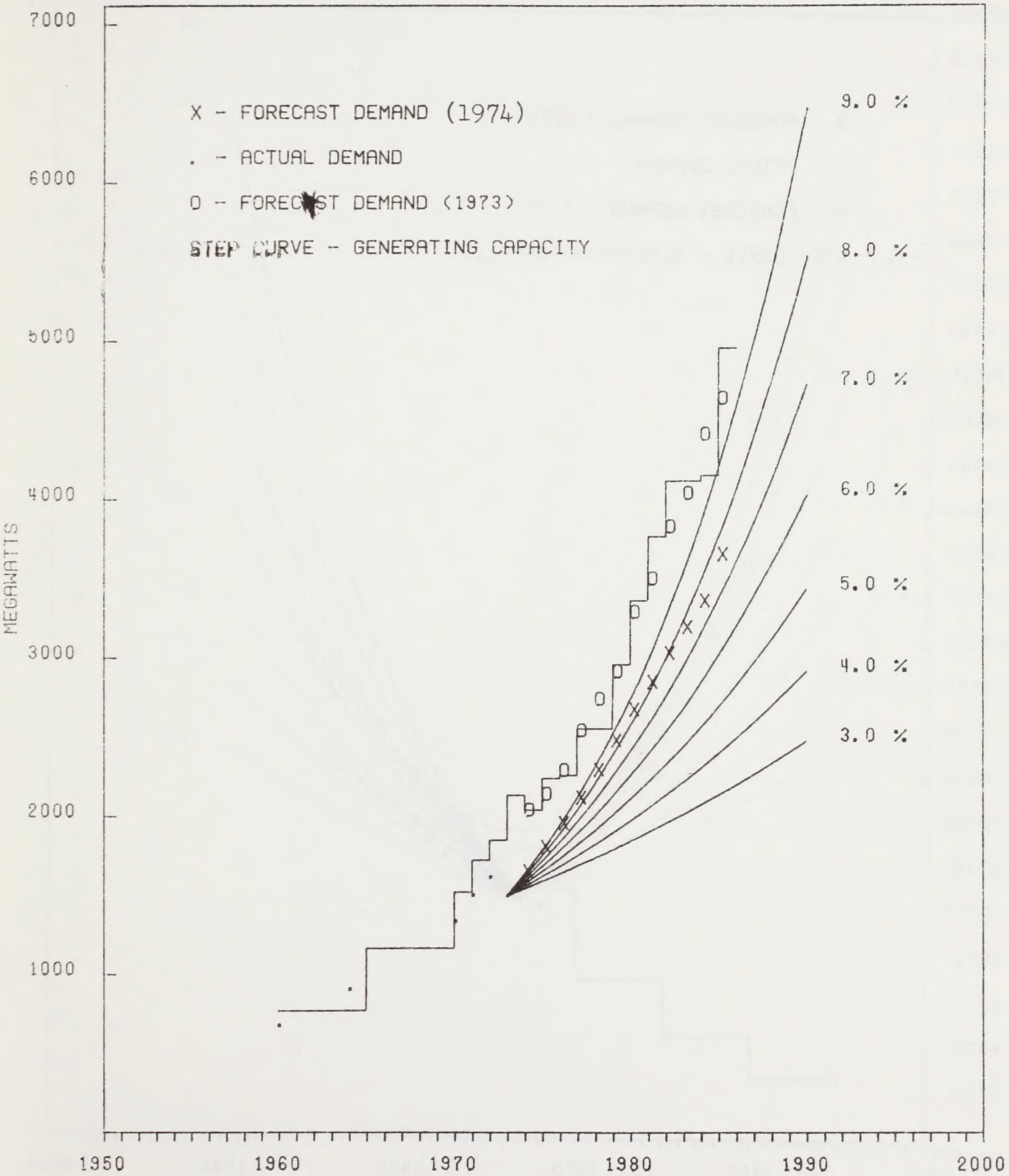
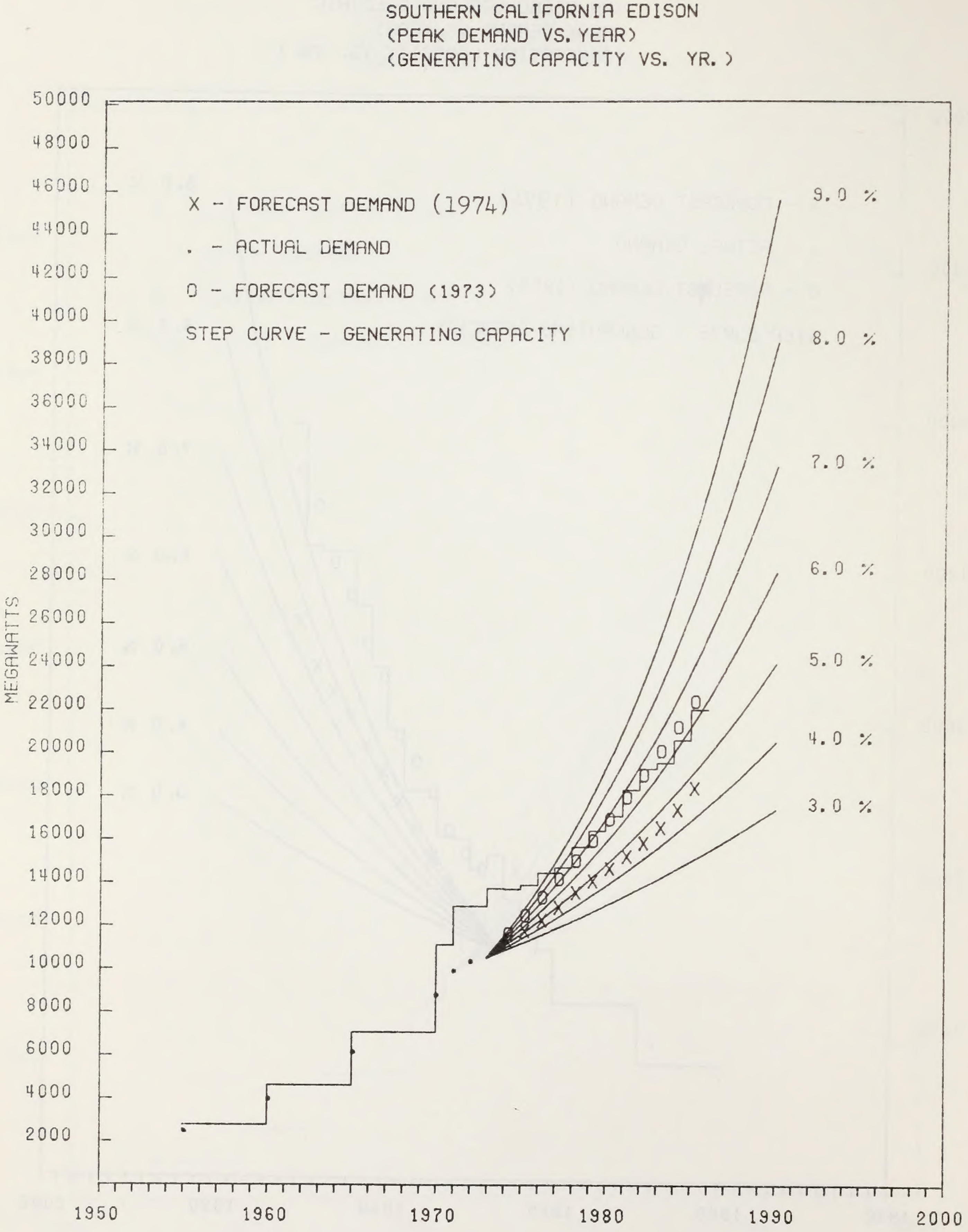


FIGURE 5



SOUTHERN CALIFORNIA EDISON
(PEAK DEMAND VS. YEAR)
(GENERATING CAPACITY VS. YR.)
X - FORECAST DEMAND (1974)
. - ACTUAL DEMAND
O - FORECAST DEMAND (1973)
STEP CURVE - GENERATING CAPACITY
9.0 %
8.0 %
7.0 %
6.0 %
5.0 %
4.0 %
3.0 %
MEGAWATTS
50000
48000
46000
44000
42000
40000
38000
36000
34000
32000
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
1950
1960
1970
1980
1990
2000

FIGURE 6
KAIPAROWITS MARKET AREA(SRP:APS:SCE:SDG&E)
(PEAK DEMAND VS. YEAR)
(GENERATING CAPACITY VS. YR.)

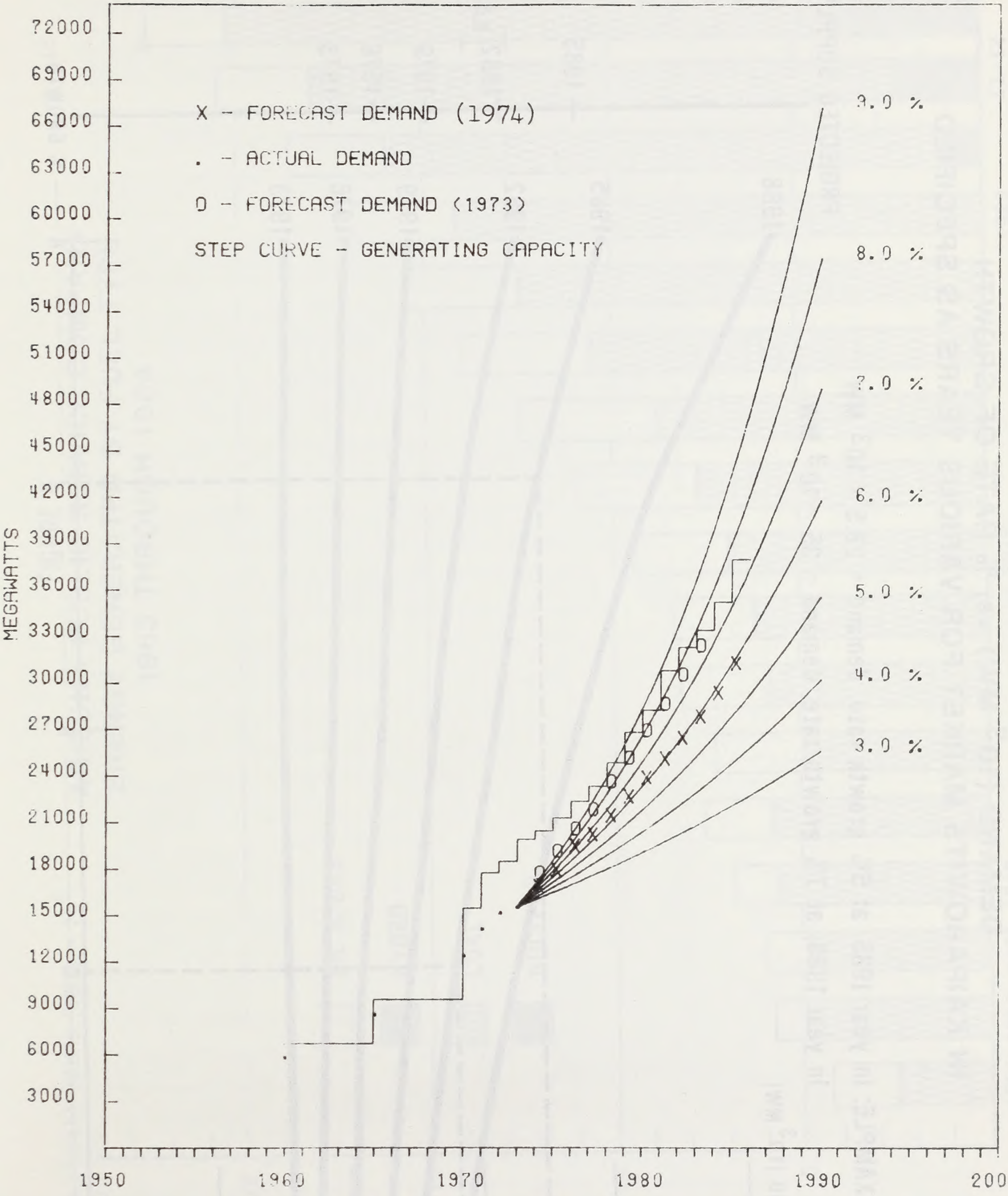


FIGURE 7
DEMAND (10^3 MW) vs. % RATE OF GROWTH IN KAIPAROWITS MARKET FOR VARIOUS YEARS AS SPECIFIED

EXAMPLE: In year 1985, at 5% growth rate, demand = 28.5×10^3 MW

In year 1985, at 7% growth rate, demand = 35×10^3 MW

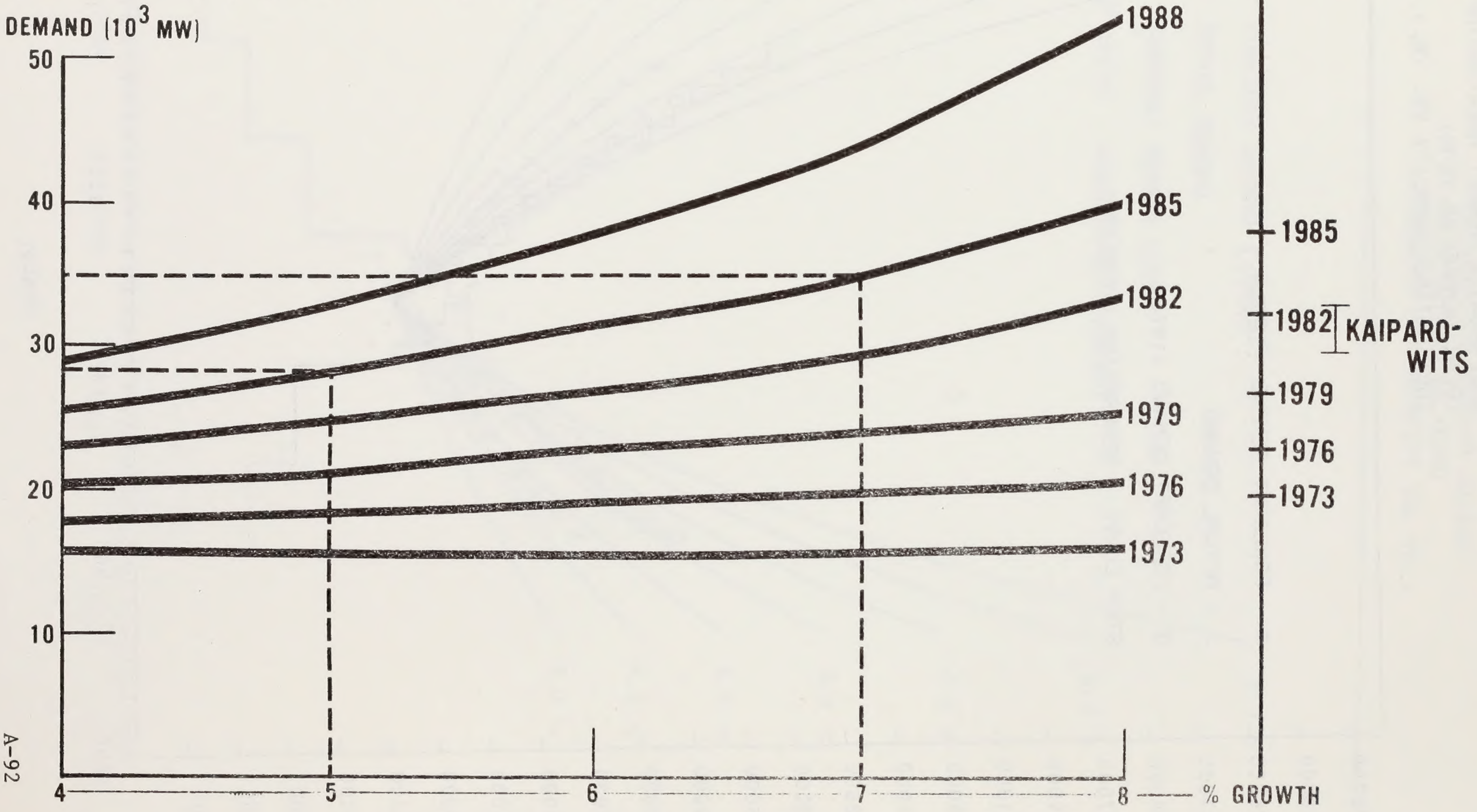


FIGURE 8
ARIZONA PUBLIC SERVICE COMPANY ENERGY GENERATED BY FUEL TYPE 1963 THROUGH 1984

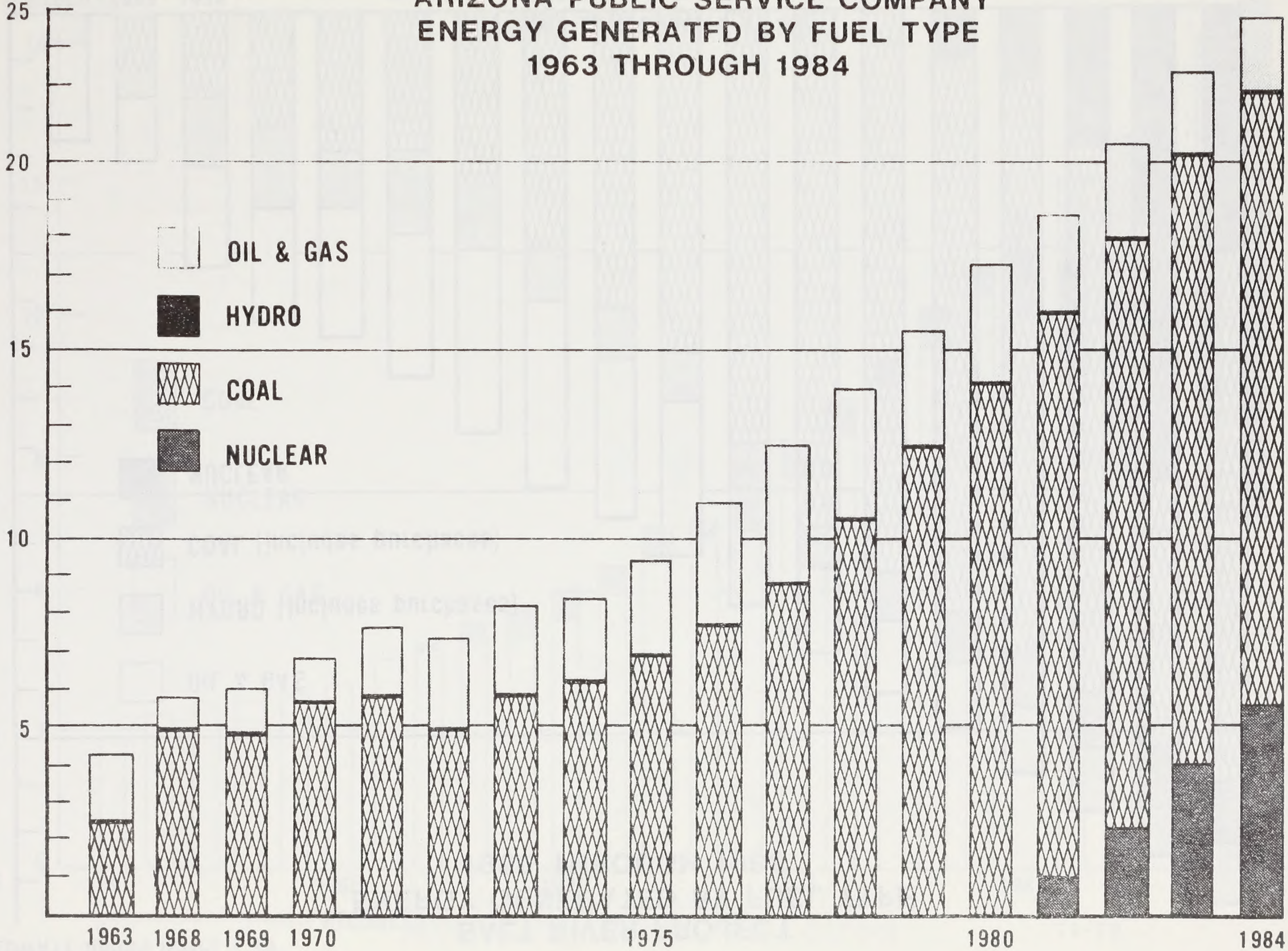


FIGURE 9

SALT RIVER PROJECT
ENERGY GENERATED BY FUEL TYPE
1960 THROUGH 1985

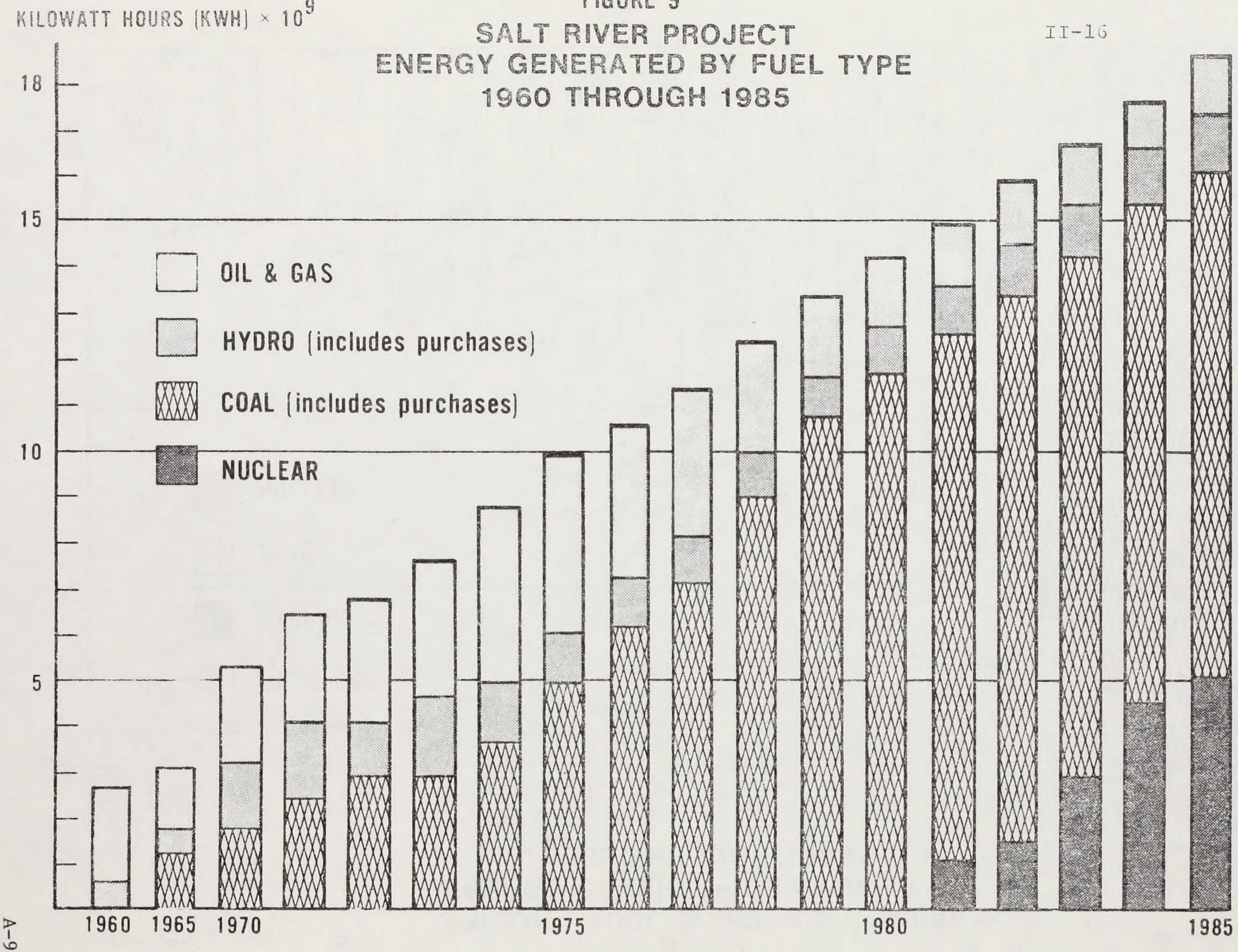


FIGURE 10
SAN DIEGO GAS AND ELECTRIC COMPANY ENERGY GENERATED BY FUEL TYPE 1960 THROUGH 1985

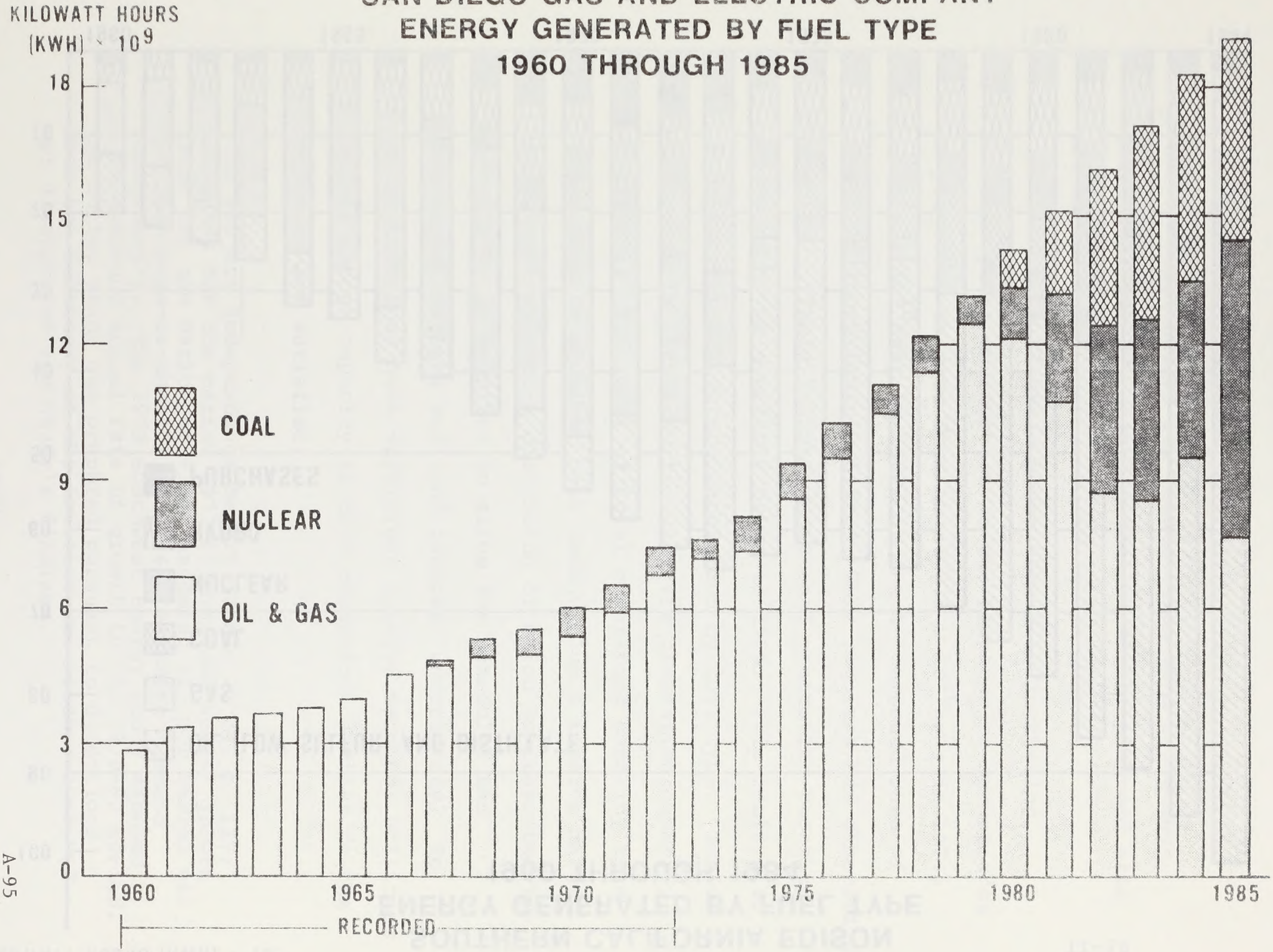
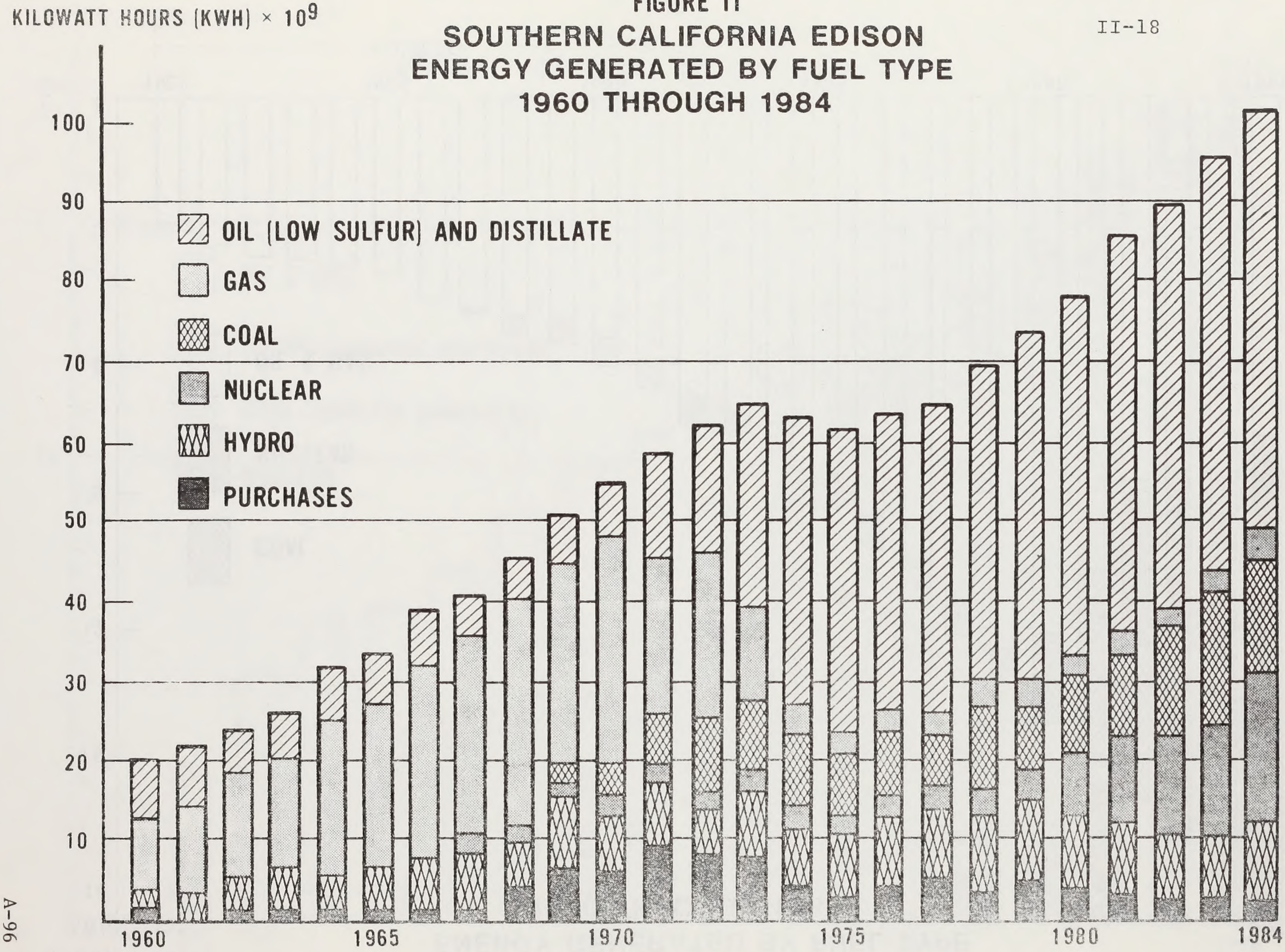


FIGURE 11

SOUTHERN CALIFORNIA EDISON
ENERGY GENERATED BY FUEL TYPE
1960 THROUGH 1984



B. Rationales

Rationales for construction of a 3,000 megawatt coal-fired generating station at the proposed site are as follows:

1. Electric power demand is increasing. Electric power consumption in the Kaiparowits market area is projected to grow from about 8.5 x 10^{10} kwhr in 1974, to 15.8 x 10^{10} kwhr in 1984, an annual compound rate of growth of approximately 6.8%.* This requires new generating capacity. (Table V lists additional generating capacity scheduled to be available prior to 1985. This table also lists current and future generation by fuel type. Tables VI through IX list specific electric generation capacity additions.) The level of total generating capacity in a system must be equal to peak demand plus a reserve margin. The reserve margin, a discussion of which is presented in Appendix C, is required to allow for scheduled and unscheduled outages and load forecast uncertainty. To insure that they have sufficient reserve margins, utilities install enough capacity so that conditions similar to the following are satisfied:

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*The Project Independence Report (Table II-24, p. 127; indicates for the period 1973-85 compound annual growth rates for the Nation of 6.3% (assuming $11 per barrel oil and "business-as-usual") and 7.4% (assuming "Demand Management"). The 1973 Southwest Energy Study assumed a 7.6% compound annual rate of growth in the 1970-80 period. The latter study was prepared pursuant to directions from the Secretary of the Interior who neither approved nor disapproved the Study's findings.

a. Margin between installed generating capacity and peak demand equal to at least 15% to 20% of annual peak demand.

b. Generating capacity margin, after deducting for scheduled maintenance, to provide sufficient capacity to allow loss of the larger of:

(1) The systems' two largest generating units or interconnections with other systems.

(2) 7% of system demand plus largest generating unit or interconnection.

c. 0.95 reliability index. (This means in the case of SCE that there would be a 95% chance of meeting demand every hour in a year.*)

2. Because of the increasing cost of oil and scarcity of natural gas, and in order to decrease reliance on oil imports, it is a National policy to shift as much as practical to use of more available domestic fuels such as coal and uranium. A Kaiparowits size oil-fired station would require approximately 80,000 barrels of oil per day in comparison to Kaiparowits 25,000 tons of coal. Assuming 1984 crude oil costs at $14.3 per barrel (Southern California Edison assumption), $11 per barrel or $7 per barrel (FEA's Project Independence Report high and low assumptions), operation of Kaiparowits could reduce the flow of dollars to foreign countries respectively by $418, $321 or $204 million per year.

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*Other utilities define the reliability index in a different, but essentially equivalent manner.

3. Baseload generating capacity should be increased in order to minimize system operations' costs. (Characteristics of baseload generation are: operation at or near full capacity during all hours that the generating unit is available and low energy costs per kilowatt hour of generation.) For example, while Southern California Edison's objective is that 40% to 50% of its capacity be baseload resources (nuclear, coal and hydroelectric), only 16% of its capacity will be so in the 1974-79 period. By 1983 Edison's baseload capacity will be increased to 25% of its total capacity of approximately 19,578 megawatts.

4. Economies of scale can be achieved through construction of large electric generating facilities.

5. The proposed site has been selected because of proximity of extensive coal reserves, inability of a Southern California area coal-fired plant to meet air emission standards, and scarcity of water in the Phoenix area.

TABLE V

GENERATING CAPACITY [MW] (ENERGY [10^{6}KWHR])

		Hydro	Oil & Gas 1/	Nuclear	Coal Less Kaiparowits	Coal Kaiparowits	TOTAL
Capacity-12/31/73 (Energy Generated During 1973)	APS	4.9 (33)	1272.4 (2,463)	- -	913.8 (5,744)	- -	2191.1 (8,888.3) 2/
	SRP	717 (1,728)	762 (3,033)	- -	402 (2,791)	- -	1,881 3/ (7,552.6)
	SDG&E	- -	2,044 (7,199)	86 (453)	- -	- -	2,130 (7,652)
	SCE	1,000 4/ (6,943)	9,410 (38,164)	344 (1,814)	1,619 (8,719)	- -	13,523 5/ (55,645)
Scheduled Additions of Capacity 1974-1984	APS	-	605	1,071	1,165	540	3,381
	SRP	(-276)	489	1,071	1,439	300	3,023
	SDG&E	-	856	491	-	702	2,049
	SCE	344	2,292	2,584	219	1,164	7,087 6/
Capacity-12/31/84 (Energy Generated During 1984)	APS	4.9 (34)	1,877.4 (1,869.5)	1,071 (5,824.5)	2,078.8 (12,792.9)	540 (3,569.3)	5,572.1 (23,630) 7/
	SRP	441 (1,204.4)	1,251 (1,020)	1,071 (4,479.1)	1,841 (9,742.5)	300 (1,117.4)	4,904 (17,563.7)
	SDG&E	- -	2,900 (9,540)	577 (3,942)	- -	702 (4,625)	4,179 (18,107)
	SCE	1,463 (6,216)	11,702 (52,790)	2,928 (21,392)	1,838 (10,727)	1,164 (7,619)	20,610 (98,744)

1/ Includes combined cycle and gas turbines.
2/ Includes purchases of 647.8 x 10^{6}KWHR.
3/ Includes purchases of 478MW hydro and 92MW coal.
4/ Includes 277MW of firm purchases and 119MW due to adverse winter hydro berate.
5/ Includes 1218MW of purchases and 68MW of off-system loses.
6/ Includes 94MW of purchases and 390MW from fuel cells installed 1979-1981.
7/ Includes 460.3 x 10^{6}KWHR sales.

TABLE VI

ARIZONA PUBLIC SERVICE COMPANY GENERATION RESOURCE ADDITIONS

(Through 1982)

Year Of Installation	Resource	Net Capacity (MW)
1974	Gas Turbines	60
1976, 1980	Combined Cycle	370
1974, 1975, 1976	Navajo Units 1,2,3 (2250 MW) (a)	315
1977, 1978	Cholla Units 2,3 (500 MW)	500
1979	Cholla Unit 4 (350 MW)	350
1980, 1981, 1982	Kaiparowits Units 1,2,3,4 (3000 MW) (b)	540
1981	Arizona Nuclear (c)	357

TABLE VII

SALT RIVER PROJECT
GENERATION RESOURCE ADDITIONS

Year Of Installation	Resource	Capacity (MW)
1974	Navajo 1 (coal)	248
	Santan 1,2,3 (combined cycle)	219
	Agua Fria 4,5 (combustion turb)	128
1975	Santan 4 (combined cycle)	66
	Agua Fria 6 (combustion turbine)	61
	Navajo 2 (coal)	241
1976	Navajo 3 (coal)	107
	Hayden 2 (coal)	200
1978	Yampa 1 (coal)	110
	Arizona Station 1 (coal)	350
1979	Yampa 2 (coal)	110
	Arizona Station 2 (coal)	350
1980	Kaiparowits Unit 1 (coal)	75
1981	Kaiparowits Unit 2 (coal)	75
	Palo Verde Generating Station	357
1982	Hayden (Colorado--Ute entitlement)	-75
	Kaiparowits Units 3 & 4 (coal)	150
	Arizona Station 3 (coal)	350

TABLE VIII

SAN DIEGO GAS & ELECTRIC COMPANY GENERATION RESOURCE ADDITION PLAN

1974-1983

Planned Operating Date	Station & Unit	Type	Capacity* (MW)	Remarks
Scheduled Units				
Oct 1974	South Bay GT 2	Gas Turbine	32	
	South Bay GT 3	Gas Turbine	64	
	South Bay GT 4	Gas Turbine	64	
May 1977	Enchina 5	Steam	292	
Sep 1980	San Onofre 2	Nuclear	228	29% share of 1140 MW Unit
Dec 1981	San Onofre 3	Nuclear	228	20% share of 1140 Unit
Planned Units				
May 1979	Undetermined 1	Comb. Cycle	404	
May 1980	Kaiparowits 1	Steam-Coal	176	23.4% of 750 MW Units
May 1981	Kaiparowits 2	Steam-Coal	175	
May 1982	Kaiparowits 3	Steam-Coal	176	
Mar 1982	Kaiparowits 4	Steam-Coal	175	
June 1984	San Joaquin 1	Nuclear	35	Possible share of first San Joaquin Unit
May 1985	Desert #1	Nuclear	770	Expected share of 1160 MW
Dec 1985	San Joaquin 2	Nuclear	35	

*Dependable winter capability. Summer capabilities of Gas Turbines and Combined Cycle units are somewhat less.

TABLE IX

SOUTHERN CALIFORNIA EDISON COMPANY GENERATION RESOURCE ADDITIONS (1974-1983)

Date	Resource	Net Capacity Added (MW)	
	Coal-Fired Generation		
1974-77	Rerate Mohave 1 & 2	-16	
1975-77	Rerate Four Corners 4 & 5	-56	
1980-82	Kaiparowits Units 1-4	1200	(a)
	Nuclear Generation		
1979-81	San Onofre 2 & 3	1824	(b)
	Combined-Cycle Generation, Fossil Fueled		
1976	Long Beach 1-7	563	
1977-78	Coolwater 3 & 4	472	
1978-79	Huntington Beach 6-11	1416	(c)
	Oil and Gas Fired Generation		
1976	Yuma Axis	25	
	Peaking Generation		
1974	Ellwood Energy Support Facility (Gas Turbine)	54	
1979-81	Fuel Cells 1-15	390	
1981-82	Big Creek Area Development (hydro.)	344	

(a) Allocation of Kaiparowits Project power to each participant has not been finalized, however an Edison share of 40% is assumed.

(b) 80% share of two 1140 MW units.

(c) An alternative is installation of combined cycle units at the Lucerne Valley site.

III. Conceptual Alternatives to the Proposed Kaiparowits Project

This section considers how electric power needs might be satisfied in the Kaiparowits market area by various alternatives to the proposed project. The following section discusses uses for other than electric power generation of energy and water resources which would be preempted by Kaiparowits as now planned. Alternatives addressed in this section include: delay or cancellation of the project; purchase of power from other systems; construction of other types of generating facilities at different sites; and investment in energy conservation. Alternatives not analyzed in detail include those which would clearly not be economically viable in the early or mid 1980's; e.g., fusion. Also not discussed are public policy options (e.g., redesign of electric power rate structures or mandatory conservation) which would have widespread impact on energy matters and, in so doing, might affect the need for Kaiparowits and/or the merits of its alternatives.*

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*For example, financial incentives and disincentives combined with regulations concerning electric power use could limit electric power demand to the point where new generating capacity would not be required. In such circumstances a decision as to whether or not to proceed with Kaiparowits would depend upon considerations of how best to use Kaiparowits coal. Discussion of the costs and benefits of public policies aimed at restricting electric power demand is beyond the scope of this report.

A consideration of the alternatives to Kaiparowits gives some idea of possible tradeoffs between economic, resource and environmental factors characteristic of the various options. The focus of the following discussion is on the economic viability and resource requirements of Kaiparowits alternatives. Environmental impacts of alternatives are mentioned here and addressed directly in the Kaiparowits Environmental Impact Statement.

A. Deferral in Consequence of Reduced Demand

Rising prices and government actions (e.g., rate restructuring or mandatory conservation) could reduce the rate of growth of demand for electric power. The date at which Kaiparowits generating capacity would be required would thereby be postponed.

Delay might allow time for substantial refinements in the scrubber technology. Delay might also allow development of environmentally preferable generating technologies making them economically feasible and removing the need for coal-fired plants such as Kaiparowits.* However, the utilities believe such technological improvements are not likely to become economic in the

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*A third potential benefit of delay would be additional time for regional planning. This could, in principle lead to lesser adverse impacts than are implicit in the present project plan. However, because Kaiparowits has received considerable analysis in the Southwest Energy Study, it is not likely that additional regional study would affect conclusions regarding the location of the Kaiparowits Project even though such study might have a large impact upon decisions concerning the location of subsequent projects.

Date	Resource	Net Capacity Added (MW)
	Purchased Power	
1974	Navajo 1 Layoff (terminates in 1981)	97
1975	Navajo 2 Layoff (terminates in 1981)	104
1975	Portland General Electric Exchange (seasonal)	100
1976	Navajo 3 Layoff (terminates in 1981)	126
	Retirements and Terminations	
1974	Vernon (diesel)	-20
1981	Navajo Layoff	-327
1982	Long Beach 10 & 11	-212

near future. Therefore, unless the demand growth rate is far less than is now projected, new technologies could not be substituted for the proposed project as planned. Moreover, as noted above, Kaiparowits could replace 3,000 megawatts of oil-fired generating capacity (i.e., 80,000 barrels per day) and might therefore be justified even in the event of zero growth.

In the event that Kaiparowits was deferred and growth in demand did occur in accordance with utilities' estimates reserve generating capacity would fall below what is considered necessary to provide adequate system reliability. Table X indicates forecast reserve margins in the event the Kaiparowits schedule was delayed. Table X assumes that demand will aproximate the utilities' current forecasts.

Table X

RESERVE MARGINS

APS (18% of Kaiparowits Output)

Year	No Delay	1 Yr. Delay	2 Yr. Delay	3 Yr. Delay
1980	20.5%	16.5%	16.5%	16.5%
81	24.9%	21.2%	17.5%	17.5%
82	20.2%	16.8%	13.3%	9.8%
83	24.3%	21.1%	17.9%	14.7%
84	24.4%	24.4%	21.4%	18.4%
85	19.2%	19.2%	19.2%	16.4%

Table X

RESERVE MARGINS (cont.)

SRP (10% of Kaiparowits Output)

Year	No Delay	1 Yr. Delay	2 Yr. Delay	3 Yr. Delay
1980	20.3%	17.9%	17.9%	17.9%
81	25.6%	23.4%	21.2%	21.2%
82	17.1%	15.0%	12.9%	10.9%
83	18.3%	16.3%	14.4%	12.4%
84	19.9%	19.9%	18.0%	16.2%
85	20.9%	20.9%	20.9%	19.2%

SDG & E (23.4% of Kaiparowits Output)

Year	No Delay	1 Yr. Delay	2 Yr. Delay	3 Yr. Delay
1980	27.5%	20.9%	20.9%	20.9%
81	34.1%	26.8%	20.5%	20.5%
82	32.6%	25.9%	20.6%	14.1%
83	30.4%	30.4%	19.3%	13.7%
84	22.3%	22.3%	22.3%	12.0%
85	37.1%	37.1%	37.1%	37.1%

SCE (40% of Kaiparowits Output)

Year	No Delay	1 Yr. Delay	2 Yr. Delay	3 Yr. Delay
1980	18.9%	16.8%	16.8%	16.8%
81	22.4%	20.5%	18.5%	18.5%
82	23.8%	22.0%	20.1%	18.2%
83	20.3%	18.5%	16.7%	14.9%
84	20.6%	20.6%	18.8%	17.2%
85	21.6%	21.6%	21.6%	20.0%

As is indicated in Item 1, Section II-B and in Appendix C, reserve margins calculated on the basis of the differential between generating capacity and peak demand are used in the determination of system reliability. In addition, the nominal 15% reserve margin is a partial indication that a system has adequate reserves. Table X suggests that a 15% reserve margin could be maintained if Kaiparowits were delayed up to two years, providing other facilities were not delayed and providing there were power transfers among the Kaiparowits participants. However, the utilities believe that the 15% margin is necessary but not sufficient, and that even though this criteria would be satisfied if the project were delayed two years, other reliability criteria and the condition that there be no delays in other projects would not be met. Therefore, any delay of the Kaiparowits Project would, in their view, lead to insufficient reserve margin to provide adequate system reliability.*

B. Purchase of Power from Outside Kaiparowits Market Area

Assuming the required transmission facilities would be available, the potential for this depends on the realization of one of two possibilities: (a) that utilities outside the Kaiparowits area have unexpected surpluses or (b) that such utilities will add capacity for the express purpose of providing power to the Kaiparowits market area.

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*See discussion in Section II, p.19; and in Appendix C.

Neither possibility is likely, for two reasons. First, all utilities are facing problems in siting generating facilities to serve their own needs; therefore, they would not exploit available sites in order to satisfy needs of other systems. Second, all utilities are faced with severe problems in financing their own facilities; again, it is exceedingly unlikely that they would draw from limited capital resources to finance facilities to help satisfy electric power demand in neighboring systems.

If purchased power were to substitute for Kaiparowits, it would be necessary for the planning of the project which would supply that power to have already progressed at least as far as Kaiparowits. No such project has been identified.

C. Coal-fired Facility at Site Within or Closer to Arizona and California Market Areas

Kaiparowits coal could be transported to coal-fired electric generating plants within Southern California and Arizona market areas. Advantages of this alternative include the avoidance of possible air pollution problems on the Kaiparowits Plateau and neighboring national parks and the freeing of 45,000 acre feet of Utah's allocation of Colorado River water for other uses. (Possible alternative uses for this 45,000 acre feet are listed in Section IV.)

Transport of coal to market areas in Southern California and Arizona would be via train or slurry pipeline.* Table XI includes data which allow an approximate comparison of the cost of transporting electric power with the cost of transporting coal. While variances in these estimates are substantial, the data suggest that transportation costs per se would not dictate against construction of coal buring electric generating stations in market areas instead of on the Kaiparowits Plateau. Since such stations would cause impermissable air quality degradation in Southern California this alternative is not viable. Moreover, such facilities would make demands on water which is even more scarce in Southern California and Arizona market areas than in Southern Utah.

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*Since the agreement which permits use of Utah's allotment of Colorado River water requires that the water be used for purposes of electric power generation, the agreement would have to be renegotiated if the water were to be used for coal slurry purposes. In comparison to the 45,000 acre feet required for condensor cooling, a slurry pipeline to serve a Kaiparowits size facility would require approximately 6500 acre feet per year.

Table XI

Relative Cost of Transportation to Market Areas (Mills/kwh)

	Rail (Unit Train)	Slurry Pipeline	Electric Transmission
Kaiparowits to Southern California 1/	7.0[2] 3.8[6]	(2,0-6.0)[6]	3.5[2] (4.2-8.4)[6]
Kaiparowits to Phoenix, Ariz. 4/ 5/	10.0[3] 6.0[6]	(1.2-3.6)[6] 7/	2.0[3] (2.4-4.9)[6]

1/ Rail and transmission line distace to Southern California approximately 500 miles.
2/ Based on Southern California Edison data.
3/ Extrapolated from Southern California Edison data.
4/ Rail distance to Phoenix approximately 800 miles; 500 miles longer than direct route because of lack of Colorado River crossings.
5/ Transmission line distance to Phoenix area approximately 300 miles.
6/ Extrapolated from 1972 Southwest Energy Study; assumes 20% increase over the Study's 1972 cost estimates.
7/ Assumes slurry pipeline routed over Glen Canyon Dam.

It is also possible to consider the alternative of using Kaiparowits coal in generating stations at sites which are neither on the Kaiparowits Plateau nor in the market areas of the owner utilities. The purpose of such siting would be to avoid the environmental impacts associated with a plant in either Southern Utah or market areas in Southern California or Arizona. In this case transport of Kaiparowits coal would be by slurry pipeline or by unit train to a site in Nevada or Eastern California. An example of such a site would be one in the vicinity of the existing 1500 megawatt coal-fired generating station, Mohave, located on the Colorado River approximately three miles south of Davis Dam.

Table XII indicates differential costs between (a) the transport of coal to Mohave and electric power to market areas and (b) transport of electric power from Kaiparowits to California market areas. This table indicates that for power to be transported to Southern California there is a savings in electric power transmission and an added cost of transport for coal.* Owing to the substantial spread in estimates of transportation cost differentials, no firm conclusion can be reached regarding the magnitude of the cost penalty (or even whether there would be one) incurred by virtue of transporting Kaiparowits coal some hundreds of miles

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*For Arizona market areas (e.g., Phoenix) the savings resulting from less electric power transmission costs would, for two reasons, be less than for the case of California markets. First, the distance to Arizona markets is shorter and therefore power transmission costs are less. Second, Mohave is on the route from Kaiparowits to Southern California so that the total distance traveled by coal plus electric power is approximately the same as that traveled by electric power in the case of generation on the Kaiparowits Plateau. On the other

Table XII

Differential cost between (a) Transport of coal by either train or slurry pipeline from Kaiparowits to Mohave and electric power from Mohave to Southern California, and (b) Transport of electric power from Kaiparowits Plateau to Southern California.

	Annual Total ($ millions)[1]	(mills/kwh)
Cost of Rail Transport of Coal[2]	107	5.1[3]
Cost of Slurry Pipeline Transport of Coal[2]		1.3 to 4.0[4]
Savings on Electric Power Transmission Costs	36	1.7[3];3.0 to 5.0[4]
Net Increment in Cost of Delivery of Power to Market (Rail plus electric vis-a-vis electric)	71	+0.1 to +3.4
Net Increment in Cost of Delivery of Power to Market (Slurry plus electric vis-a-vis electric)		-3.7 to +2.3

[1] Southern California Edison data.
[2] Assumes Kaiparowits-Mohave distance approximately 350 miles.
[3] Extrapolated from Southern California Edison data.
[4] Extrapolated from 1972 Southwest Energy Study; assumes 20% increase over Study's 1972 cost estimates.

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hand, Mohave is not on the shortest route between Kaiparowits and Phoenix, and therefore the total distance traveled by coal plus electric power to Phoenix, is greater than would be the case for electric power generated at Kaiparowits and transmitted to Phoenix.

to a generating station. However, whatever the cost differential is, it is likely to be overshadowed, in deliberations of where to locate the plant, by considerations relating to water availability, environmental affects, and socioeconomic factors involving the region in which the plant would be built.

D. Oil and Gas-Fired Generating Facilities

It is now recognized that the use of oil or gas for generation of baseload electric power represents a relatively inefficient use of those resources. For this reason, new facilities fueled by either natural gas or oil are not realistic alternatives to Kaiparowits.

However, mention should be made of several hybrid possibilities which involve coal gasification or liquefaction facilities.

Costs of electric power in 1974 dollars at the point of entry into a Southern California distribution system have been estimated for various gasification, liquefaction, and transportation options. These estimates must necessarily be tentative because gasification or liquefaction facilities on the magnitude of Kaiparowits have not yet been constructed. Figure 12 and Table XIII following it provide an indication of comparative costs and energy efficiencies of the following.[1]

Option A. Electric power generation (coal plus scrubbers) at the Kaiparowits Plateau plus 500 miles transmission of electric power to Southern California.

Option B. Electric power generation (low Btu gas from coal, no scrubbers) at the Kaiparowits Plateau plus 500 miles transmission of electric power to Southern California.[2,3]

Option C. Electric power generation (high Btu gas from coal, no scrubbers) at the Kaiparowits Plateau plus 500 miles transmission of electric power to Southern California.[2]

Option D. Electric power generation (liquefied coal no scrubbers) at the Kaiparowits Plateau plus 500 miles transmission of electric power to Southern California.[2]

Option E. Conversion of coal to high Btu gas at the Kaiparowits Plateau plus 500 miles transport of gas by pipeline plus electric power generation in Southern California.

Option F. Conversion of coal to low Btu gas at the Kaiparowits Plateau plus 500 miles transport of gas by pipeline plus electric power generation in Southern California.[3]

Option G. Conversion of coal to liquid at the Kaiparowits Plateau plus 500 miles transport of liquid plus electric power generation in Southern California.

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[1] These options do not include gasification or liquefaction of Kaiparowits coal for purposes other than generation of electric power. Such options are discussed in Section IV; they are not considered as alternatives to Kaiparowits because coal is abundant and its use for electric power generation does not compete with use of gasification or liquefaction.

[2] Options B, C and D would be selected only if gasification or liquefaction were an economic means of meeting air emission standards.

[3] Low Btu gas could, if used in a combined cycle generation system (i.e. gas turbine plus conventional boiler heated by turbine exhaust gases), lead to generation efficiencies upwards of 50% in comparison with Kaiparowits 38%. However, the technology permitting achievement of such high generating efficiencies at the 3000 megawatt level will not be available for a plant being built during the years in which Kaiparowits is scheduled for construction.

Figure 12 contains the following assumptions:

Fixed costs (interest, depreciation, taxes, etc.) associated with generation, liquefaction, and gasification facilities are 20% of investment in plant.*

Operating, maintenance and administrative costs (exclusive of fuel) associated with generation, liquefaction, and gasification facilities are 10% of investment.

Cost of coal delivered to coal-fired generating station on the Kaiparowits Plateau is \$15/ton, \$0.66 per 10^6 Btu (22.6 x 10^6 Btu/ton).

Investment cost for coal-fired generation station on the Kaiparowits Plateau is \$400 per kilowatt of generating capacity.

Investment cost for gasified or liquefied coal-fired generating facility is \$300 per kilowatt of generating capacity.

Investment cost for low Btu coal gasification facility is \$600 per 10^6 Btu per day production capacity.**

Gasification and liquefaction plants operate 75% of time.

Cost of transporting 10^6 Btu of high Btu gas 500 miles is \$0.10.

Cost of transporting 10^6 Btu of low Btu gas 500 miles is \$0.30.

Cost of transporting 1 kwhr (3423 Btu) of electric power 500 mile is \$0.004.

Electric generating efficiency is 38%.

Efficiency of converting coal to low Btu gas is 75%.

Efficiency of converting coal to high Btu gas is 60%.

Efficiency of converting coal to liquid is 70%.

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*See Project Independence, p. 286.

**From W. W. Bodle and K. C. Vyas, Oil and Gas Journal, August 26, 1974, p. 74.

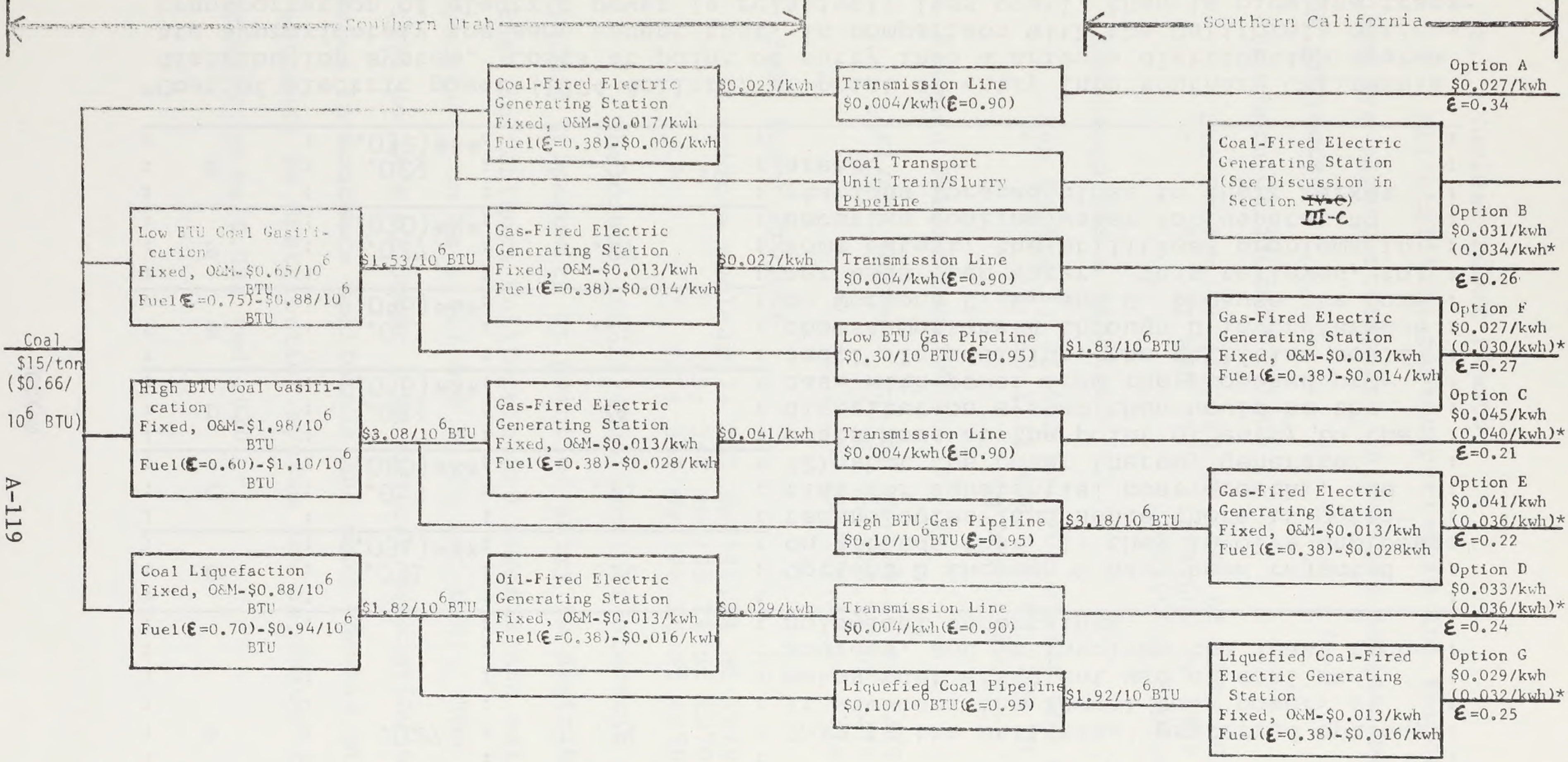

FIGURE XII

*Cost figures in parentheses based on Southern California Edison estimates of gasification and liquefaction costs.

Table XIII

Option	Cost* ($/kwh)	Efficiency**	Remarks
A	.027	.34	This is the utilities' preferred option; it provides the lowest cost power, it makes most efficient use of coal resources, and it involves the least technological uncertainty.
B	.031 (.034)***	.26	Options B through G have been rejected on grounds that (1) they involve unproved technologies (and hence there is potential for substantial cost growth), and (2) that the power thereby generated costs more at the point of entry to the distribution system than would be the case with power from the proposed project. In addition, the utilities would choose Options A through D in preference to Options E, F, and G, because the former uses Utah water. This relieves, to some extent, the utilities' problems in securing cooling water for generating stations located close to their market areas.
C	.045 (.040)***	.21	
D	.033 (.036)***	.24	
E	.041 (.036)***	.22	
F	.027 (.030)***	.27	
G	.029 (.032)***	.25	

*Cost of electric power (1974 dollars) at point of entry into southern California distribution system. Costs at point of entry into a Arizona distribution system are approximately the same except that, in comparison with the California options, transportation of electric power is relatively less costly than is pipeline transportation of gas or liquid.

**Efficiency with which energy originally stored in coal is converted into electric energy as measured at point of entry into southern California distribution system.

***Cost estimates in parentheses are based on Southern California Edison's forecast cost of coal gasification and liquefaction.

E. Nuclear Power Plants

All utilities participating in the Kaiparowits Project are also participants in various nuclear power plant projects:

Southern California Edison

San Onofre I; 344,000 kw (80% of 430,000); 1968.
" " II and III; 1,824,000 kw (80% of 2,280,000), approx. 1980.

San Diego Gas & Electric

San Onofre I; 86,000 kw (20% of 430,000 kw); 1968.
" " II and III; 456,000 kw (20% of 2,280,000) approx. 1980.

Arizona Public Service

Arizona Nuclear I; 357 Mw (28.1% of 1270 Mw); 1981.
" " II; 357 Mw (28.1% of 1270 Mw); 1983.
" " III; 357 Mw (28.1% of 1270 Mw); 1984.

Salt River Project

Arizona Nuclear I; 357 Mw (28.1% of 1270 Mw); 1981.
" " II; 357 Mw (28.1% of 1270 Mw); 1983.
" " III; 357 Mw (28.1% of 1270 Mw); 1984.

The costs (in 1974 dollars) of electric power in 1985 from Kaiparowits at point of entry to distribution systems in Southern California and Phoenix are estimated respectively to be $.027 and $.025 per kwhr. The 1985 costs in 1974 dollars of power from nuclear generating stations located in Southern California and near Phoenix at point of entrance to distribution system are estimated respectively to be $.022 and .020.

There is general recognition that energy for all major new baseload electric generating facilities to serve the Kaiparowits market area will be either from coal related or nuclear processes. The decision to construct one type over the other will depend upon evaluation of various economic, technical and environmental factors; and the time at which the evaluation is made. In this case, the choice was dictated by the availability of coal, participating utilities' policy to reach what they consider a proper balance between nuclear and fossil fuels, and uncertainties with regard to the scheduling of nuclear generating stations.

F. Geothermal Generating Fossil

The companies participating in the Kaiparowits project are investigating the potential of geothermal energy sources to serve needs in their respective market areas. The geothermal activities of these companies are as follows:

San Diego Gas & Electric Company's geothermal energy exploration and development began in January 1971. Wells were drilled in the Imperial Valley of California and flow tests were conducted to define the extent and potential of the geothermal resources. Subsequently, SDG&E engaged in testing equipment and overcoming scaling problems caused by the mineral-laden geothermal fluid. Since there is not yet any commercially proven equipment for converting the heat energy of the geothermal brines found in the Imperial Valley, they propose to construct a geothermal test facility in 1975. Assuming the most optimistic results with the test facility, the program could lead to an installed capacity of between 50 and 75 megawatts by 1981. This compares with SDG&E's 702 megawatt share of Kaiparowits generating capacity.

Southern California Edison entered into an agreement on September 6, 1972 with Southern Pacific Land Company and Phillips Petroleum Company to investigate the development of Imperial Valley geothermal brines to ascertain the feasibility of generating electricity. Initially, field efforts, commenced during the second quarter of 1973, were directed to establishing a reliable well production and injection system with emphasis on resolution and/or minimization of scale and corrosion problems. Power generation field testing will follow by the second quarter of 1975. The research work is expected to be completed by early 1976 resulting in recommendations for possible future pilot or demonstration "geothermal brine" generating units.

In early 1974, Edison signed a letter-of-intent with Magma Energy, Inc. for research and development of a binary cycle geothermal power plant in Mono County near Mammoth Lakes, California. The 10 Mw demonstration unit will be built on property owned by Magma and, subsequent to successful performance testing by January 1978, Edison will consider the purchase of the plant.

Arizona Public Service Company and the Salt River Project joined with Tuscon Gas & Electric to partially fund exploratory drilling in Chandler, Arizona. The results to date have not been satisfactory and do not warrant expectations that geothermal energy would be a viable alternative to Kaiparowits. APS and SRP as members of the Electric Power Research Institute support work done by EPRI in the field of geothermal energy. None of the Kaiparowits participants believes that geothermal sources will, in the time frame of interest, provide more than a small fraction of the energy expected from Kaiparowits.

G. Investment in Energy Conservation Services*

An alternative to investment in the Kaiparowits electric generating station would be investment in systems which reduce energy consumption. For example, investment in more efficient lighting and cooling in commercial structures, or in residential thermal insulation would achieve essentially the same end as would investment in additional electric generating capacity for inefficient lighting, heating and cooling.

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*The conservation policies as stated by the Kaiparowits participants are listed in Appendix B.

Any discussion of alternative investment raises the question, "Alternative investment by whom?" Utilities have not traditionally made substantial investments in providing energy conservation services; legal barriers may in some cases prevent their doing so. But whether it be by utilities or by energy consumers, investment in conservation will lead to substantial monetary and energy savings.

One example of a system which provides economic and energy savings is that installed in commercial buildings for the purpose of monitoring and controlling the internal environment. Such a system includes elements which monitor temperature and humidity and which control blowers, chillers, pumps, and furnaces. Designed primarily to reduce peak power demand by 10% to 15% such a system also provides 15% to 25% savings in total energy consumption.

A typical 300,000 square foot commercial building in Southern California requires approximately 30 kwhr/yr/sq. ft. Peak power demand in such a structure is approximately 7.5 watts/sq. ft. If average savings could be achieved through use of an environmental control system, peak demand would be reduced by .75 watts/sq. ft. and total energy consumption by 1,800 kwhr/yr. Comparative costs and energy consumption with and without the above system:

Capital cost of environmental control system	$50,000
Capital cost of generating environmental and transmission capacity necessary in absence of environmental control system @ $500/kw.	$112,500
Cost of operating environmental control system; includes fixed costs of 20% and operating costs of 10% of investment.	$15,000/yr
Cost of 1,800,000 kwhr @ $0.032/kwhr.	$57,600/yr
Cost savings by virtue of installation of environmental control system.	$42,600/yr
Amount of energy resources not consumed as a result of 600,000 kwhr savings.	3000 bbls oil or 1050 tons coal/yr

In brief, investment in energy conservation systems brings about substantial energy resource and economic savings. However, the Kaiparowits utilities do not consider investment in conservation services to be a realistic alternative to investment in the proposed project. In the first place, these utilities imply that, legal barriers notwithstanding, they do not consider large scale investment in energy conservation programs within the scope of their activities. Moreover, as was noted previously (Section IIB), Kaiparowits is justified partly because it will displace existing oil fueled facilities. Thus, the utilities believe the Kaiparowits Project is needed in any event and it should proceed concurrently with programs which reduce electric power consumption.

H. Investment in Advanced Generation and Transmission Systems

A variety of advanced concepts in central station baseload generation and transmission are being developed. Some are closer to the point of economic feasibility than others. Some are of major significance and others represent modest improvements in efficiency.

The relative significance of a concept depends upon its potential for playing a role in satisfying electric energy demand. As with other alternatives, it is likely that if an advanced concept were to become economic, a higher priority would be given to decommissioning existing oil and gas facilities than to cancellation of Kaiparowits.

The following table lists the most promising central station and transmission techniques along with indications of significance and level of development. None of these have reached a point of development where they might affect the need for Kaiparowits 3000 megawatts.

Concept	Potential Significance	Year of availability as an economically viable option
Fusion	Major	post 2000
Breeder Fission	Major	post 1990
Central Station		
Solar:		
Solar thermal	Major	post 1990
Photovoltaic	Moderate Major	1985-1990
Bio-Conversion	Minor	Possibly never in the Southwest U.S. due to lack of water.

Concept	Potential Significance	Year of availability as an economically viable option
Wind	Moderate	post 1985
Magnetohydrodynamics	Moderate	1990
Large Fuel Cells	Moderate	1990-2000
Batteries	Moderate	1985
Nuclear Reactor Gas Turbine (possible elimination of most of water requirement in gas cooled reactors at some decrease in thermal efficiency)	Major	1990
High Voltage DC Transmission	Major*	1980
SF_6 Insulation Systems	Major*	1980
Superconducting or near-superconduction cables	Major*	1980
UHV Transmission	Major*	1980
Underwater Transmission	Major*	1980

*The significance of advances in the transmission technology lies in the fact that such advances mitigate siting problems by making possible greater separation between points of generation and consumption.

IV. Alternative Uses of Resources

Operation of the Kaiparowits Project would consume coal and water resources which might be used for purposes other than generation of electric power. Because coal reserves are abundant, the use of coal for purposes of electric power generation does not compete with the use of coal for other purposes such as gasification, liquefaction. Table XIV indicates human, material, land, and energy resource requirements for Kaiparowits and its most viable alternatives.

The question of whether the use of Colorado River water for cooling Kaiparowits condensors represents the best use of this resource is a more complex question. The 45,000 acre feet required each year for condensor cooling is approximately:

0.7%--0.8%	of total estimated available Upper Colorado Basin flow*
1.6%--2.0%	of currently estimated unused Upper Colorado Basin flow*
3.0%--3.4%	of Utah's total share of Upper Colorado Basin flow*
4.8%--5.8%	of unused portion of Utah's share of Upper Colorado Basin flow*

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*From Figures 3 and 6, U.S. Department of the Interior Water for Energy Management Team, "Report on Water for Energy in the Upper Colorado Basin," (July, 1974). The percentages listed above are based on the Department of Interior's "assumed" and "conservative" flows. These flows are 86.7% and 77.3% of the 7.5 million acre feet per year which were the basis for appropriations under the Upper Colorado Basin compact.

Table XV indicates alternative uses of this water and the economic value of the product associated with such uses. Existing studies are inconclusive with regard to the likelihood of energy resource development in the Upper Colorado Basin being constrained by water availability prior to the year 2000.*

Moreover, whatever the merits of diverting Kaiparowits water to other purposes, there are practical obstacles to doing so. The participating utilities have contractual agreements with the State of Utah and the Department of the Interior which allow the use of this water solely for use in association with electric power generation at the Kaiparowits site.

Related to the water question is that the Upper Colorado River basin surface water supply is overappropriated in Utah;**i.e., water rights exceed supply. However the matter is resolved, the fact of overappropriation is unlikely to affect the Kaiparowits Project schedule.

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*Ibid.

**Federal Energy Administration, Project Independence Report, "Water Requirements, Availabilities, Constraints and Recommended Federal Actions," (U.S. Water Resources Council, Washington, D.C.) p. 99.

TABLE XIV

	Investment (Billions of Dollars)	Steel (Tons)	Concrete (Tons)	Land (Acres)	Engineering M/Yrs	Skilled Workers M/Yrs	Energy Resources Consumed/Yr
Kaiparowits Project As Proposed (Including Transmission Line)	$1.43	55,400	11,550	11,610	755	7,310	9×10^6 tons coal plus transmission line losses (see Assumption 4).
Coal Burning Generating Station in Southern California (Including Railroad Requirements)	$1.48	91,400	11,500	18,860	710	7,200	9×10^6 tons coal plus diesel oil for RR (see Assumption 4).
3000 Megawatts of Nuclear Generating Capacity In Kaiparowits Market Area (No Transmission)	$1.28	38,080	28,250	1,570	2,008	11,670	3000 kgm U235

ASSUMPTIONS:

1. Transmission line assumed from Kaiparowits to Mohave for case of Project as proposed.
2. Length of railroad alignment assumed to be twice that of transmission line for case of rail transport of coal.
3. These estimates are approximate - based on minimum engineering - accuracy range is ± 25%.
4. Transmission line losses and energy consumed by rail transport are both 5% to 10% of energy generated.

Table XV

Alternative Uses of 45,000 Acre Feed to be Used in Condensor Cooling at the Kaiparowits Project

	Approx. Impact on Oil Supply	Approx. value of annual Output ($ millions)
Kaiparowits (3000 megawatts, excludes water requirements for coal mine and associated community which might require an additional 7000 acre feet.)	Displaces 80,000 bpd	483 at generating station @$0.023/kwh
Oil Shale Production	200,000 to 600,000 bpd. (1)	730-2,190 @$10 per bbl.
Coal Liquefaction	60,000 to 400,000 bpd; (40,000 to 300,000 bpd net). (2)	220-1,460 @$10 per bbl.
Coal Gasification	100,000 to 400,000 bpd. equivalent; (50,000 to 260,000 bpd. net). (3)	365-1,460 @$10 per bbl.
Coal Slurry	Sufficient for transport of approximately 200,000 tons of coal per day (equivalent of 700,000 barrels of oil per day)	
Irrigation of approximately 30,000 acres with typical Utah crop pattern (4)		

(1) No net energy figure is given since the oil shale process, which consumes approximately 0.4 barrels of shale oil for each barrel produced, consumes energy which otherwise would not be used; therefore, the concept of net efficiency of the process is not meaningful in so far as questions of alternative uses of resources are concerned.

(2) W. W. Bodle and K. C. Vyan, "Clean Fuels From Coal," The Oil and Gas Journal, August 26, 1974; p. 74.

(3) High BTU gas; ibid.

(4) From information supplied to FEA by Upper Colorado River Office, Bureau of Reclamation in letter dated August 13, 1974.

V. Conclusions

The purpose of the foregoing discussion was to consider the need for the Kaiparowits Project, alternative means of satisfying that need, and alternative uses of the resources which will be consumed therein. The following conclusions related only to energy aspects of the Kaiparowits Project. Any considerations of the Project as a whole should combine these conclusions with those resulting from an assessment of environmental impacts.

A. The FEA supports the Kaiparowits Project participants' position which holds that maintenance of adequate system reliability requires that Kaiparowits generating capacity be available as now scheduled. This support is based in part on the assumption that demand will grow approximately in accordance with the utilities' forecasts and that generating reserve requirements as specified by the utilities are necessary. While in actuality, demand may grow at a lesser rate, there is no solid basis for assuming such a lesser growth. The utilities' forecasts and reserve calculations are accepted because they are the most credible available.*

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*Recognizing that demand forecasts must necessarily reflect many subjective judgments, the FEA believes it important that there be forecasts compiled independently of those produced within the electric utility industry. Such forecasts would help to insure balance, they would lend greater credence to Government decisions permitting construction of generation and transmission facilities, and they would lead to more widespread participation in the economic planning process. The FEA is considering means by which independent forecasts might be encouraged.

B. FEA would support use of Kaiparowits coal for electric power generation even if growth in demand were less than now forecast as a result of increasing costs, government regulatory policies, and consumer conservation practices. This support would be based on the grounds that operation of a 3000 megawatt coal burning facility, in lieu of existing oil burning plants, would lead to the displacement of 80,000 barrels of oil per day. Early construction or conversion of a facility which uses coal from the Kaiparowits Plateau would help achieve the President's proposed goal to eliminate by 1980 oil-fired plants from the Nation's baseload generating capacity.

C. At present, there are two technically viable and relatively economical power generation alternatives to Kaiparowits: (1) nuclear plants in the Kaiparowits market area, and (2) transportation of Kaiparowits coal to a power plant site where air and water constraints are less severe than at the proposed site in Southern Utah. The nuclear alternative was rejected by the utilities on the grounds that in comparison with the relatively high likelihood of a coal-burning power plant being brought into operation according to schedule, uncertainties in scheduling of nuclear plants made it unwise to place additional reliance upon nuclear power at this time. The utilities dismissed the alternative of transporting Kaiparowits coal to another site on the grounds that other potential sites were, with respect to a site on the Kaiparowits Plateau, less suitable in regard to one or more of the following: water availability, ability to meet air quality standards, and economics of transport of Kaiparowits coal. (The environmental pros and cons of possible alternative sites are compared in the Environmental Impact Statement).

D. Other alternatives involve unproven and less energy efficient, but probably viable technologies. These are gasification or liquefaction of Kaiparowits coal and use of this coal for electric power generation either at the Kaiparowits Plateau or in Arizona and California market areas. A determination of the net desirability of such alternatives requires a comparison of their possible environmental advantages with disadvantages inherent in technological uncertainties.

E. Of some concern is whether the Kaiparowits Project leads to efficient use of limited resources. The fact that Kaiparowits displaces 80,000 barrels of oil per day is significant. Operation of Kaiparowits would reduce expenditures for foreign oil @$11 per barrel by approximately $320 million per year. Because coal is abundant, its use in this project does not compete with its use in other projects.

Water is another matter. Kaiparowits consumes approximately the same quantity of water as would be required in an oil shale production operation yielding

200,000 to 600,000 barrels per day or a coal gasification plant yielding the equivalent of 50,000 to 260,000 barrels per day.

If the availability of water in the Southwest is the limiting factor in the production of energy resources, a net energy gain could be realized if Kaiparowits water from the Colorado River were shifted to use in oil shale production.* Such a shift would involve either constructing the Kaipaorwits generating station at a site where water was more plentiful, or using a plant design with substantially less water demand at the Kaiparowits Plateau.

Water demand for the Kaiparowits Project could be reduced if the plant were built to use low Btu gas in a combined cycle generating system or with dry cooling system cooling towers. Neither of these technologies is considered to be economically feasible for this size installation in the time frame of interest.

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*As noted on Page IV-2, there are legal obstacles to prevent using this water for other than electric power generation.

Appendix A

For purposes of decision making regarding additions to generating capacity, utilities compile forecasts of future demand. The primary assumptions made by each of the Kaiparowits participants in arriving at its current demand forecast were:

Arizona Public Service (1975-1979, 7.3% per year demand growth; 1980-1984, 5.9% per year demand growth):

- Population growth will be greater than 4%.
- GNP per person will continue to increase.
- Decreasing availability of natural gas will lead to increased use of electric power for heating and cooling; namely, 55% of new home construction in 1974 and 75% in 1977.
- Effect of energy conservation has made a difference between 1973 and 1974 forecasts of 5.5% for 1976, 3% for 1979 and 0.4% for 1983.

Salt River Project (1975-1984, 6.75% average per year demand growth; 1980-1985):

- Demand is forecast on the basis of the historical relationship between growth in peak load and growth in customers. Each year, forecasts are updated to reflect current population projections.
- Customer growth between 6.2% and 6.5% per year from 1975-1984.
- Population growth greater than 3% per year from 1975-1984.

San Diego Gas & Electric (1975-1979, 8.4% per year demand growth; 1980-1984, 6.5% per year demand growth):

- Population will grow at rate of 2.75% in years 1975-1980, and 2.7% in years 1980-1985.

- o Historical relationship between commercial growth and population will continue.
- o Historical relationship (J.D.) between population, household size and household use will continue.

Southern California Edison (1975-1980 and 1980-1985, 4.7% per year demand growth):*

- o Population will grow at rate of 1.7% in years 1975-1979, and 1.6% in years 1980-1985.
- o Increased prices, more energy efficient building design, and a conservation ethic will lower demand below that which has been forecast prior to the oil embargo; however, forces towards decreased use will be tempered by momentum inherent in existing behavior and connected loads.
- o Real Gross State Product Growth rate will be 3.7% in 1975-1980 period.
- o Government policies will continue to seek full employment for a growing labor force which will lead to increased energy consumption.
- o Uncertain natural gas supplies and the national effort to minimize dependence upon foreign energy resources will result in decreased use of oil and natural gas.
- o Residential development will concentrate in hotter regions of the service territory, which will add to increased power requirements for air conditioning.
- o Direct solar heating devices will not become economically competitive before 1985.

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*Southern California Edison states that: "The major methods of attaining energy conservation have been incorporated into (its) forecast.... These reductions are aimed at cutting energy waste and could be accomplished without causing severe economic dislocation. Any further reduction would lead to such economic dislocation as unemployment, reduced production, and the associated reduction in the personal income of the population served by SCE."

Appendix B

Energy conservation policies as stated by the Kaiparowits participants are as follows:

Southern Claifornia Edison

A. PRINCIPLE

The Company, as an investor-owned utility, is in business to meet the demand of its customers for electric service. Efforts to encourage the efficient use of electricity, and the conservation thereof, are consistent with the goal of providing electrical energy and related services in a manner which is satisfactory to all customers.

B. ACTION RULES

1. Management and Conservation of Electric Energy

   a. The Company shall undertake activities directed at reducing the rate of growth in demand for electric energy of residential, commercial, industrial, and agricultural customers by:

      (1) Providing information to residential customers designed to assist them in their choices for efficient and economical use of electric power.

      (2) Providing consulting services to commercial, industrial, and agricultural customers directed at advising them to reduce their overall energy requirements, and encouraging them to take actions to minimize pollution.

      (3) Encouraging trade associations and builder-developer groups to improve the efficiency of electrical equipment and institute building design, equipment selection, and construction practices which result in energy savings.

b. The Company shall plan for and operate its facilities in a manner which is consistent with increasing the efficiency of electric energy generation and the Company's use of electric energy.

c. The Company shall endeavor to develop and implement means of increasing the efficiency of electric energy uses and the elimination of wasteful practices.

2. Advertising/Communications

a. The Company shall not promote the increased use of energy through advertising, or incentive programs to builders and consumers.

b. The Company shall communicate to its customers and the general public what the Company is doing, is trying to do, and why, to the end that the best understanding and appreciation of the Company's activities will be achieved.

(1) Accomplishments of the Company, in, and positions on, electric energy Conservation, environmental protection, and social action shall be fully communicated to employees and the general public.

(2) The Company shall conduct advertising aimed at providing environmental and conservation information, and encouraging shifts in consumer energy-use patterns to optimize utilization of all energy forms.

San Diego Gas & Electric Company

MARKETING DIVISION
ENERGY CONSERVATION PROGRAMS

The following is an outline of existing and planned programs and activities designed to conserve energy, and to advise customers on the wise use of energy.

The items are presented under headings that follow our Sales Department, Marketing Programs Department, Marketing Research Department and Advertising Department organization.

Sales Department

Major customers offer the greatest opportunity for our efforts to promote wiser use of energy, peak-shaving, reduction in utility bills and more efficient utilization.

Sales Department sections are presently servicing 600 major industrial and commercial accounts. These accounts have been identified and assigned individually to Commercial/ Industrial and Sales representatives. The "assigned account" program constitutes the majority of these representatives' time and responsibilities. Specifically they have been directed to establish liaison with top management and operating personnel of the assigned account firms.

In addition to assuring that these customers receive good service, our representatives have been instructed to counsel the customer on the elimination of wasteful energy practices and reassignment of energy utilizing equipment to prevent coincident usage with peak energy periods.

Following are plans in consideration or under way:

Industrial Customers

1. We are developing charts for the use of Sales Representatives to demonstrate to commercial and industrial customers the energy savings (as well as the dollar savings) in curtailing

use of pilots connected with space heating, metal processing, solution tanks, etc. when the equipment is not in use, such as over week-ends.

2. Our Energy Utilization Engineer is studying development of a packet for Sales Representatives and Comm/Ind Representatives to use in demonstrating to industrial customers the energy saving (and dollar saving) possible by insulation of heated solution tanks. This material may be expanded into a seminar or course for Sales Representatives and plant engineers, plant managers, etc.

3. A similar study has resulted in plans to produce a Pipe Insulation Manual which will be loaned to plant engineers and major customers to encourage them to evaluate the present insulation of their steam and hot solution lines. Astounding results are seen from preliminary tests. The Manual is a very complex engineering text, but computerized pages reduce it to a simple application for industrial firms. We will encourage them to Xerox pages of the book that apply. The manual is produced by the National Insulation Manufacturers Association.

4. A program to enable our Sales Representatives to show industrial firms how to establish their own minimum ventilation requirements is in process. A manual produced by the American Conference of Governmental Industrial Hygienists has been acquired for the purpose. A kit will be supplied so that Sales

Representatives can advise plant engineers how to remove contaminants at the source, rather than diluting air in the whole work area, thus wasting energy and dollars by over-ventilating.

5. We are developing monthly electric demand charts to be supplied to representatives calling on major accounts. These are actual print-outs of high demands of recent occurrence in a plant or customer premise, demonstrating graphically the effect on both customer billing (dollars) and SDG&E's system peak (energy). The Company representatives will use these to assist large customers to pin-point problems and solve them. They are designed to move load off our peak where possible (such as shutting off lights immediately after plant shut-down in late afternoon, which in a test case kept 1600 kw of lighting off our afternoon peak... or moving certain heavy peices of equipment off daily peak, such as a 1000 kw furnace recently re-scheduled).

6. Electrical Maintenance Seminars are being conducted on a test basis with some of our major industrial customers. They are designed to illustrate how properly maintained heavy equipment will perform more efficiently and with less "down" time (dollars) and less production time (dollars as well as energy) when given correct and timely maintenance. In planning is a brochure for the purpose. A possible supplement is an Energy Conservation Award as an incentive in the program.

Government Sales

1. A plan is currently under way, in cooperation with Marketing Research Department, to conduct an exhaustive survey of U.S. Navy family housing in the San Diego area to determine possible methods of minimizing energy use. The program and materials will be produced by SDG&E, while the implementation will be entirely done by the Navy, who are most enthusiastic about the project. The survey will examine every area of energy use, including appliances, heating, cooling, hot water use, the effect of insulation, etc.

2. Preliminary meetings have been held looking toward a series of high-level conferences between SDG&E officials and command-level Navy people to examine every possible angle of efficient gas utilization, in view of possible curtailment in the coming winter months.

3. Energy consultaions between Governmental Sales Representatives and local Navy commands are scheduled throughout the remainder of 1973, aimed at peak-shaving, moving loads off Company peaks, and more efficient use of energy by the Navy.

Home Economics

1. Continuing efforts are planned to add to the series of Appliance Utilization Booklets, which have been widely acclaimed throughout our industry as a pioneer project in providing the customer with advice and information on the wise use of energy.

An added plan this year is to work with agencies for the disadvantaged and low-income groups, as well as to expand Spanish-language booklets, needed by Mexican-American communities in our serving territory.

2. A new plan in the Home Economics management contemplates better communication with women's groups, ethnic groups, low income and disadvantaged through a "newsletter" or "bulletin" to be issued monthly or perhaps quarterly. They have found a great need for direct communication--there is no agency in San Diego supplying directly to the consumer information on nutritional meals, efficient cooking of foods, how to save money on food purchases, food preparation, energy use, etc. Timely is the U.S. Government's "Plentiful Foods Program," which would be included in the proposed communication. Women expect recipes, but the inclusion of energy-saving hints will be an important aim in such a publication.

3. Home Economics is scheduling production of a new series of "Cue" cards, which are interspersed with Recipe cards in the packets given to attendees at the hundreds of Women's Programs conducted by this department each year. The "Cue" cards contain hints on how to save money on utility bills (also saving energy), how to use appliances more efficiently, proper maintenance for energy conservation, etc.

Consumer Affairs

Our Consumer Affairs Counsellor has a comprehensive plan for production in 1973 of a consumer advice leaflet on "How To Cut Energy Use (And Save Dollars) Through Regular Maintenance of Household Equipment." Probes are going out now by mail to ask major appliance manufacturers for in-house and consumer literature on the subject. The need was discovered in reviewing the log of customer inquiries.... many ask how to maintain equipment so as to operate it more efficiently and more economically.

Marketing Programs Department

1. In conjunction with Advertising, Marketing Programs Department is developing a TV commercial on the efficient use of room air conditioners, offering an efficiency calculator and an air conditioning booklet describing how to keep the home at comfortable temperature through efficient air conditioner usage.

2. Further research is being conducted into the relative efficiencies of heating euqipment, with special emphasis on the heat pump, and its benefits. For all-electric customers, these benefits include reduced energy use and reduced cost compared to standard electric heating-cooling systems. For customers in dual territory, the benefits are eventual heating-cooling economy when gas prices increase, and conservation of gas, a scarce commodity. Aimed at customers who have already decided

to air condition, it will not influence demand for air conditioning, only the choice of systems. Also involves educational efforts with air conditioning contractors, builders and developers, advising them of heat pump efficiency.

3. A training program is in process to train sales representatives in use of a new computerized interior lighting design system which designs efficient lighting layouts for commercial/industrial customers. Current testing shows very encouraging results.

4. A major program in 1973 is our Insulation Program. In September 1972 a Thermal Insulation Study was completed which indicated that up to 50% savings could be realized on heating and air conditioning cost in a fully insulated house. Furthermore, a survey indicated that 45% of the single family homes in San Diego County were uninsulated. As a result of the potential savings demonstrated in these studies, the insulation program was developed. It is directed toward two markets--new single family/multi family dwellings, and existing single family/multi family dwellings. SDG&E's objective in new home construction is to up-grade the building codes in San Diego County to require a minimum of 6 inches of insulation in the ceiling and 3 and 1/2 inches in the walls. At such time as this is accomplished, an effort will be launched to urge all existing home owners to install ceiling insulation wherever possible. It is contemplated that SDG&E will operate with the local insulation industry to insure that the above is achieved.

Marketing Research Department

By using existing charts from billing demand meters, Marketing Research is building load curves for commercial and industrial customers. The curves will measure the effect of load upon our peaks and show where shifting the demand will build a more favorable load factor. A growing number of demand meters have also been placed on residential units to accumulate representative load profiles of residential use.

Advertising Department

1. In planning for 1973, a series of 4-page inserts for local issues of national magazines and local magazines, on the "Energy Crisis" and what SDG&E is doing about it, is being developed.

2. Advertising themes for 1973 include this objective: "sell the virtue of energy saving--and offer ways to do it." To achieve this objective, TV commercials featuring animated "talking appliances" have been created to generate "top of the mind" awareness, especially among women, of how to save energy. Computer animation enables us to bring energy saving out of the ordinary into a new level of consciousness--at the same time offering booklets for customer-related information.

Outside Efforts

1. Efforts to encourage the development of automatic ignitors to replace gas pilot lights on ranges, furnaces and

clothes dryers are being pursued among manufacturers. Mr. Zitlau recently wrote a letter to appliance and control manufacturers urging a crash program on this matter.

2. We are working with utilities and electrical leagues in the Western states to attempt to establish Energy Efficiency Ratios for different appliances--particularly room air conditioners. It is a difficult task, but we feel the consumer should know which brand will be least costly to him.

Salt River Project

The Salt River Project pursues a public communications and education program designed to encourage prudent use of electric power by its customers. The program urges customers to adopt practices that would serve to both reduce peak demands and conserve energy. Such practices include regulation of thermostatic controls, use of insulation to reduce heat losses and transfers, use of drapes, blinds, and other means typically found or available for use in homes to reduce space heating energy requirements, and methods for securing the most efficient use of appliances such as electric dishwashers and washing machines. In addition, SRP works to assure that minimum standards for installation of equipment, insulation and other means of restricting heat losses are satisfied in new construction utilizing electric space heating. Active campaigns are currently maintained to promote use of more efficient space heating and cooling devices. Advertising and incentive programs, such as wiring allowances and support of dealer promotions, formerly used by many utilities to promote the use of electric energy, have been discontinued.

SRP will continue to seek means to effectively promote prudent electric energy management practices.

Arizona Public Service Company

It is the policy of Arizona Public Service Company to stress the wise and efficient use of electricity and natural gas supplied to customers. Further, it is APS policy to review continually all company operations to determine where improvements can be made to increase efficiency and conserve energy.

APS energy conservation efforts include but are not limited to:

- Research and development programs relative to new energy forms and sources.
- Power production efficiency measures.
- Reduction of power transmission and distribution losses.
- Consumer education programs promoting wise energy management and efficient energy usage.
- Adoption of internal operations policies designed to take advantage of the highest efficiencies possible in transportation, heating and cooling of buildings, and the use of all energy consuming machinery and equipment.

The scope and nature of the energy conservation programs of Arizona Public Service Company are on file with the Federal Power Commission pursuant to FPC Order No. 495, issued November 13, 1973, and reported in FPC Docket R-454.

Appendix C

MARGIN ANALYSIS OF GENERATING SYSTEMS

In order to provide reliable service to the public during times when forced outages are experienced at some generating stations, the installed generating capacity for U.S. utility companies is designed to be in excess of the anticipated peak loads. This incremental generating capacity over peak load is called margin. The margin requirements for utility systems arise due to unscheduled outages at particular plants which, for conventional power plants, are due to component failures. These unscheduled outages are separate from outages for scheduled maintenance and seasonal deratings of power plants.

There are various approaches to calculating the margin requirements. The simplest and one of the oldest approaches is to provide a generating capacity 15 to 20 percent in excess of peak demand. With the addition of very large power plants, some utilities adopted the loss of the two largest risks or, alternatively, loss of the largest risk plus 7 percent of peak demand. Because of the increased capital investment costs of power plants, a more precise determination of total generating requirements is desirable, which is based on probabilistic calculations, subject to a loss of load criterion. The most widely used method based on probabilistic techniques is called the "Loss of Load" method. This method measures the required reserve as a function of the probability of loss of capacity to meet demand. The term loss of load will usually be expressed in terms of days per year that some loss of load can be expected. The duration of the loss is unspecified. A common criterion for loss-of-load reliability of a system is one day in ten years. This means that on the average, over a ten year span, an electric generating system with this reliability would have an aggregate loss of load condition of only one day.

Because different systems have different characteristics, reliability calculations yield reserve margins which depend upon the particular characteristics of each system. For example, the utilities encompassed by the Mid-Continent Area Reliability Coordination Agreement required approximately 12% reserves to have a loss of load condition of one day per ten years while the New England systems required a 21% reserve to provide the same level of reliability.

APPENDIX I-2

Federal and State Ownership Distribution Within Coal Lease Area

APPENDIX 1-2

FIGURE 1

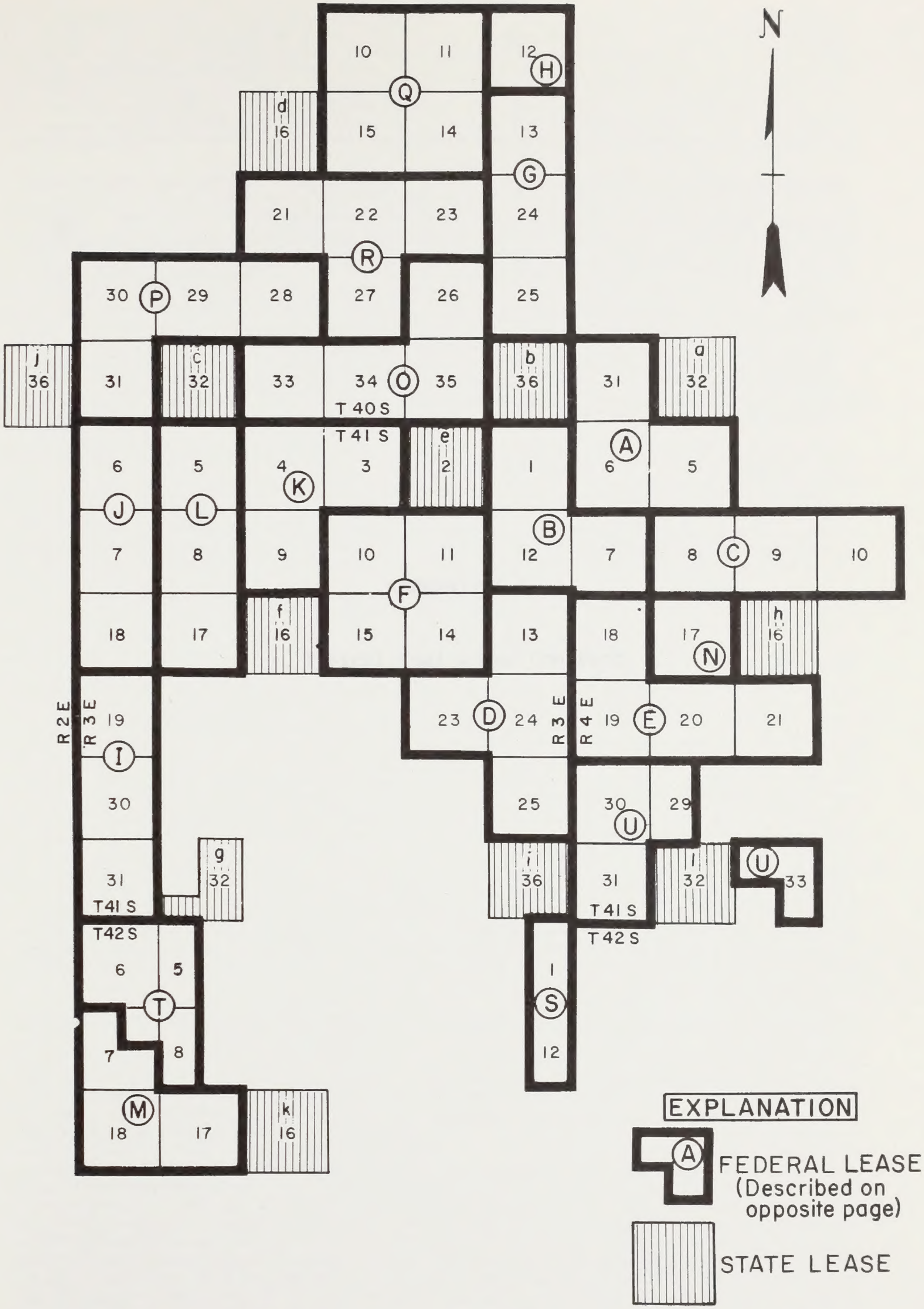
FEDERAL AND STATE OWNERSHIP DISTRIBUTION WITHIN COAL LEASE AREA

KAIPAROWITS PROJECT

(Resources Company, Mono Power Company, New Albion Resources Company)

Federal			State		
Map Designation	Lease Number	Acreage	Map Designation	Lease Number	Acreage
A	U-087805	2,064.44	a	19427	640.00
B	U-087806	1,945.32	b	19432	640.00
C	U-087807	1,920.00	c	19650	640.00
D	U-087828	2,560.00	d	19651	640.00
E	U-087833	2,517.68	e	19653	690.44
F	U-087834	2,560.00	f	19654	640.00
G	U-087835	1,920.00	g	19655	400.00
H	U-087836	640.00	h	19656	640.00
I	U-092138	1,891.44	i	19678	640.00
J	U-092139	1,934.73	j	19679	640.00
K	U-092140	2,022.48	k	19680	640.00
L	U-092141	1,972.16	l	19786	640.00
M	U-092142	1,750.20	Total		7,490.44
N	U-096486	640.00			
O	U-096494	2,560.00			
P	U-096495	2,559.84			
Q	U-096496	2,560.00			
R	U-096497	2,560.00			
S	U-096508	658.28			
T	U-096509	1,478.70			
U	U-0101142	1,562.80			
Total		40,277.35			

Federal	40,277.35
State	7,490.44
TOTAL	47,767.79



FEDERAL AND STATE OWNERSHIP DISTRIBUTION WITHIN COAL LEASE AREA

ILLUSTRATION I

APPENDIX I-3

Typical Coal Lease Contract

Form 4-696
(January 1964)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

COAL LEASE

Land Office
Salt Lake City, Utah

Serial Number
Utah 037806

This lease, entered into on the 1st day of November, 1965, by the United States of America, the lessor, through the Bureau of Land Management, and

Resources Company
P. O. Box 1432
Phoenix, Arizona

Associated Southern Investment Company
100 Long Beach Boulevard
Long Beach, California

New Albion Resources Co.
P. O. Box 168
San Diego, California

, the lessee, pursuant and subject to the terms and provisions of the Act of February 25, 1920 (41 Stat. 437), as amended, hereinafter referred to as the Act, and to all reasonable regulations of the Secretary of the Interior now or hereafter in force which are made a part hereof,

WITNESSETH:

Sec. 1. *Rights of Lessee.* The lessor, in consideration of the rents and royalties to be paid and the conditions to be observed as hereinafter set forth does hereby grant and lease to the lessee the exclusive right and privilege to mine and dispose of all the coal in the following-described tracts of land, situated in the State of Utah:

Salt Lake Meridian, Utah

T. 41 S., R. 3 E.,
sec. 1 and 12.

T. 41 S., R. 4 E.,
sec. 7.

GEOLOGICAL SURVEY
SALT LAKE CITY, UTAH
MINING BRANCH

containing 1,945.00 acres, more or less, together with the right to construct all such works, buildings, plants, structures, and appliances as may be necessary and convenient for the mining and preparation of the coal for market, the manufacture of coke or other products of coal, the housing and welfare of employees, and subject to the conditions herein provided, to use so much of the surface as may reasonably be required in the exercise of the rights and privileges herein granted.

Sec. 2. In consideration of the foregoing, the lessee hereby agrees:

a) Bond. To maintain the bond furnished upon the issuance of this lease, which bond is conditioned upon compliance with all the provisions of the lease, and to increase the amount or furnish such other bond as may be required.

b) Rental. To pay the lessor annually, in advance, for each acre or fraction thereof covered by this lease, beginning with the date hereof, the following rentals: 25 cents for the first year; 50 cents for the second, third, fourth, and fifth years, respectively; and $1 for the sixth and each succeeding year during the continuance of the lease, such rental for any year to be credited against the first royalties as they accrue under the lease during the year for which the rental was paid.

See Sec. 2(c) on last page of lease.

(c) Royalty. ~~To pay the lessor a royalty of cents on every ton of 2,000 pounds of coal mined during the first 20 years succeeding the execution of this lease. Royalties shall be payable quarterly within 30 days from the expiration of the quarter in which the coal is mined.~~

(d) Minimum production. Beginning with the sixth year of the lease, *except* when operations are interrupted by strikes, the elements, or casualties not attributable to the lessee, or unless on application and showing made, operations shall be suspended when market conditions are such that the lessee cannot operate *except* at a loss or suspended for the other reasons specified in Section 39 of the Act, to mine coal each year and pay a royalty thereon to a value of $1 per acre or fraction thereof. Operations under this lease shall be continuous *except* in circumstances described or unless the lessee shall pay a royalty, less rent, on such minimum amount of the leased deposits, for one year in advance, in which case operations may be suspended for that year.

(e) Payments. To make rental payments to the Manager of the appropriate Land Office, *except* that when this lease becomes productive the rentals and

royalties shall be paid to the appropriate Regional Mining Supervisor of the United States Geological Survey, with whom all reports concerning operations under the lease shall be filed. All remittances to the Manager of the Land Office shall be made payable to the Bureau of Land Management, those to the Geological Survey shall be made payable to the United States Geological Survey.

(f) Plats, reports, maps. At such times and in such form as the lessor may prescribe, to furnish a plat showing development work and improvements on the leased lands and a report with respect to stockholders, investment, depreciation, and costs. To furnish in such form as the lessor may prescribe, within 30 days from the expiration of each quarter a report covering such quarter, certified by the superintendent of the mine, or by such other agent having personal knowledge of the facts as may be designated by the lessee for such purpose, showing the amount of leased deposits mined during the quarter, the character and quality thereof, amount of its products and byproducts disposed of and price received therefor, and amount in storage or held for sale. To keep and prepare maps of the leased lands in accordance with the appropriate regulations.

(g) Weights. To determine accurately the weight or quantity and quality of all leased deposits mined, and to enter accurately the weight or quantity and quality thereof in due form in books to be kept and preserved by the lessee for such purposes.

(h) Inspection. To permit at all reasonable times (1) inspection by any duly authorized officer of the Department, of the leased premises and all surface and underground improvements, works, machinery, equipment, and all books and records pertaining to operations and surveys or investigations under this lease; and (2) the lessor to make copies of and extracts from any or all books and records pertaining to operations under this lease, if desired.

(i) Assignment. To file for approval in the appropriate Land Office within 90 days from the date of execution, any assignment or transfer made of this lease, whether by direct assignment, operating agreement, working or royalty interest, or otherwise. Such instrument will take effect the first day of the month following its approval by the Bureau of Land Management, or if the assignee requests, the first day of the month of approval. The showing required to be made with an assignment or transfer is set forth in the appropriate regulations.

(j) Nondiscrimination clauses. During the performance of this contract the lessee agrees as follows:

(1) The lessee will not discriminate against any employee or applicant for employment because of race, creed, color, or national origin. The lessee will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, creed, color, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The lessee agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

(2) The lessee will, in all solicitations or advertisements for employees placed by or on behalf of the lessee, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

(3) The lessee will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the said labor union or workers' representative of the lessee's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The lessee will comply with all provisions of Executive Order No. 10925 of March 6, 1961, as amended, and of the rules, regulations, and relevant orders of the President's Committee on Equal Employment Opportunity created thereby.

(5) The lessee will furnish all information and reports required by Executive Order No. 10925 of March 6, 1961, as amended, and by the rules, regulations, and orders of the said Committee, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Committee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the lessee's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this lease may be cancelled, terminated, or suspended in whole or in part and the lessee may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 10925 of March 6, 1961, as amended, and such other sanctions may be imposed and remedies invoked as provided in the said Executive Order or by rule, regulation, or order of the President's Committee on Equal Employment Opportunity, or as otherwise provided by law.

(7) The lessee will include the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the President's Committee on Equal Employment Opportunity issued pursuant to Section 303 of Executive Order No. 10925 of March 6, 1961, as amended, so that such provisions will be binding upon each subcontractor or vendor. The lessee will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however,* that in the event the lessee becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the lessee may request the United States to enter into such litigation to protect the interests of the United States.

(k) Land disposed of with coal deposits reserved to the United States. If the lands embraced herein have been or shall hereafter be disposed of under laws reserving to the United States the deposits of coal therein, to comply with all conditions as are or may hereafter be provided by the laws and regulations reserving such coal.

(l) Operations, wages, freedom of purchase. To comply with the appropriate operating regulations, to exercise reasonable diligence, skill, and care in the operations of the property, and to carry on all operations in accordance with approved methods and practices as provided in the operating regulations, having due regard for the prevention of injury to life, health or property, and of waste or damage to any water or mineral deposits; to fairly and justly weigh or measure the coal mined by each miner, to pay all wages due miners and employees, both above and below ground, at least twice each month in lawful money of the United States; to accord all miners and employees complete freedom of purchase; to restrict the workday to not exceeding eight hours in any one day for underground

workers, except in cases of emergency; to employ no boy under the age of sixteen and no girl or woman, without regard to age, in any mine below the surface; unless the laws of the State otherwise provide, in which case the State laws control.

(m) Taxes. To pay when due, all taxes lawfully assessed and levied under the laws of the State or the United States upon improvements, output of mines, or other rights, property, or assets of the lessee.

(n) Overriding royalties. Not to create, by assignment or otherwise, an overriding royalty interest in excess of 50 percent of the rate of royalty first payable to the United States under this lease or an overriding royalty interest which when added to any other outstanding overriding royalty interest exceeds that percentage, excepting, that where an interest in the leasehold or in an operating agreement is assigned, the assignor may retain an overriding royalty interest in excess of the above limitation if he shows to the satisfaction of the Bureau of Land Management, that he has made substantial investments for improvements on the land covered by the assignment.

(o) Delivery of premises in case of forfeiture. In case of forfeiture of this lease, to deliver up to the lessor in good order and condition the land leased, including all buildings, and underground timbering and such other supports and structures as are necessary for the preservation of the mine or deposit.

Sec. 3. The lessor expressly reserves:

(a) Rights reserved. The right to permit for joint or several use such easements or rights-of-way, including easements in tunnels upon, through, or in the land leased, occupied, or used as may be necessary or appropriate to the working of the same or other lands containing the deposits described in the Act, and the treatment and shipment of the products thereof by or under authority of the Government, its lessees or permittees, and for other public purposes.

(b) Disposition of surface. The right to lease, sell, or otherwise dispose of the surface of the leased lands under existing law or laws hereafter enacted, insofar as said surface is not necessary for the use of the lessee in the extraction and removal of the coal therein, or to dispose of any resource in such lands which will not unreasonably interfere with operations under this lease.

(c) Monopoly and fair prices. Full power and authority to promulgate and enforce all the provisions of Section 30 of the Act to insure the sale of the production of said leased lands to the United States and to the public at reasonable prices, to prevent monopoly, and to safeguard the public welfare.

(d) Readjustment of terms. The right reasonably to readjust and fix royalties payable hereunder and other terms and conditions at the end of 20 years from the date hereof and thereafter at the end of each succeeding 20-year period during the continuance of this lease unless otherwise provided by law at the time of the expiration of any such period. Unless the lessee files objections to the proposed terms or a relinquishment of the lease within 30 days after receipt of the notice of proposed terms for a 20-year period, he will be deemed to have agreed to such terms.

(e) Waiver of conditions. The right to waive any breach of the conditions contained herein, *except* the breach of such conditions as are required by the Act, but any such waiver shall extend only to the particular breach so waived and shall not limit the rights of the lessor with respect to any future breach; nor shall the waiver of a particular cause of forfeiture prevent cancellation of this lease for any other cause, or for the same cause occurring at another time.

Sec. 4. *Relinquishment of lease.* Upon a satisfactory showing that the public interest will not be impaired, the lessee may surrender the entire lease or any legal subdivision thereof. A relinquishment *must* be filed in *duplicate* in the appropriate Land Office. Upon its acceptance it shall be effective as of the date it is filed, subject to the continued obligation of the lessee and his surety to make payment of all accrued rentals and royalties and to provide for the preservation of any mines or productive works or permanent improvements on the leased lands in accordance with the regulations and terms of the lease.

Sec. 5. *Protection of the surface, natural resources, and improvements.* The lessee agrees to take such reasonable steps as may be needed to prevent operations from unnecessarily: (1) causing or contributing to soil erosion or damaging any forage and timber growth thereon; (2) polluting the waters of springs, streams, wells, or reservoirs; (3) damaging crops, including forage, timber, or improvements of a surface owner; or (4) damaging range improvements whether owned by the United States or by its grazing permittees or lessees; and upon any partial or total relinquishment or the cancellation or expiration of this lease, or at any other time prior thereto when required by the lessor and to the extent deemed necessary by the lessor, to fill any sump holes, ditches and other excavations, remove or cover all debris, and, so far as reasonably possible, restore the surface of the leased land to its former condition, including the removal of structures as and if required. The lessor may prescribe the steps to be taken and restoration to be made with respect to lands of the United States and improvements thereon.

Sec. 6. *Removal of equipment, etc., on termination of lease.* Upon termination of this lease, by surrender or forfeiture, the lessee shall have the privilege at any time within a period of 90 days thereafter of removing from the premises all machinery, equipment, tools and materials, *except* underground timbering placed by the lessee in or on the leased lands, which are necessary for the preservation of the mine. Any materials, tools, appliances, machinery, structures, and equipment, subject to removal as above provided, which are allowed to remain on the leased lands shall become the property of the lessor on expiration of the 90-day period or such extension thereof as may be granted because of adverse climatic conditions, but the lessee shall remove any or all of such property where so directed by the lessor.

Sec. 7. *Proceedings in case of default.* If the lessee shall not comply with any of the provisions of the Act or the regulations thereunder or default in the performance or observance of any of the provisions of this lease, and such default shall continue for a period of 30 days after service of written notice thereof by the lessor, the lessor may institute appropriate proceedings in a court of competent jurisdiction for the forfeiture and cancellation of this lease as provided in Section 31 of the Act. If the lessee fails to take prompt and necessary steps to prevent loss or damage to the mine, property, or premises, or danger to the employees, the lessor may enter on the premises and take such measures as may be deemed necessary to prevent such loss or damage or to correct the dangerous or unsafe condition of the mine or works thereof, which shall be at the expense of the lessee. However, the lessee shall not be held responsible for delays or casualties occasioned by causes beyond the lessee's control.

Sec. 8. *Heirs and successors in interest.* Each obligation hereunder shall extend to, and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns of the respective parties hereto.

Sec. 9. *Unlawful interest.* No Member of, or Delegate to, Congress, or Resident Commissioner, after his election or appointment, or either before or after he has qualified and during his continuance in office, and no officer, agent, or employee of the Department of the Interior, except as provided in 43 CFR 7.4(a)(1), shall be admitted to any share or part in this lease or derive any benefit that may arise therefrom; and the provisions of Section 3741 of the Revised Statutes of the United States, as amended (41 U.S.C. Sec. 22); and Sections 431, 432, and 433, Title 18, U.S.C., relating to contracts, enter into and form a part of this lease so far as the same may be applicable.

Sec. 2 (c). Royalty. To pay the lessor a royalty of 15 cents on every ton of 2,000 pounds of coal mined by underground methods and 17½ cents on every ton of 2,000 pounds of coal mined by surface methods, including auger mining, for the first 10 years, and 17½ cents on every ton of 2,000 pounds of coal mined by underground methods and 20 cents on every ton of 2,000 pounds of coal mined by surface methods, including auger mining, for the second 10-year period. Royalties shall be payable quarterly within 30 days from the expiration of the quarter in which the coal is mined.

Sec. 10. Mining or exploratory operations shall not be conducted which, in the opinion of the Regional Mining Supervisor, Geological Survey, would be hazardous to oil and gas production **

** or would unreasonably interfere with the orderly development and production under oil and gas leases issued for the same lands prior to the date of the permit going to preferential right lease.

THE UNITED STATES OF AMERICA

By ______________________
(Signing Officer)

Ed. D. Cox

Acting Chief, Minerals Section
(Title)

OCT 29 1965
(Date)

WITNESS TO SIGNATURE OF LESSEE

____

____

____

RESOURCES COMPANY,
ASSOCIATED SOUTHERN INVESTMENT COMPAN
NEW ALBION RESOURCES COMPANY
(Signature of Lessee)

By ______________________
(Signature of Lessee)

Howard L. Edwards
141 ~~East~~ First South
Salt Lake City, Utah
Agent and Attorney-in-Fact
(Signature of Lessee)

(If this lease is executed by a corporation, it must bear the corporate seal)

APPENDIX I-4

Agreement Between the Central Utah Water Conservancy District and Resources Company, Associated Southern Investment Company and New Albion Resources Company dated May 19, 1965

APPENDIX I-4

AGREEMENT

THE CENTRAL UTAH WATER CONSERVANCY DISTRICT, a body politic of the State of Utah, herein called "District," and RESOURCES COMPANY, a corporation, ASSOCIATED SOUTHERN INVESTMENT COMPANY, a corporation, and NEW ALBION RESOURCES COMPANY, a corporation, herein called "Companies," have this 19th day of May, 1965, agreed as follows:

I.

DEFINITIONS

As used in this agreement:

(a) "The Central Utah Water Conservancy District" means a body politic of that name organized by decree of the Fourth Judicial District Court, State of Utah, dated March 2, 1964, under the authority of Chapter 9, Title 73, Utah Code annotated, 1953, as amended.

(b) "Central Utah Project" means the project of the United States, Bureau of Reclamation, consisting of the Vernal, Bonneville, Upalco, Jensen and Uintah Units and the Ultimate Phase.

(c) "Initial Phase" means that part of the Central Utah Project authorized by the Colorado River Storage Project Act, 43 U.S.C. 620, including the Vernal Unit, which is complete, the Bonneville Unit, which is described in Bureau Definite Plan Report dated August, 1964, and the Jensen, Upalco and Uintah Units as set out in the "Applications of the District for the Initial Phase" which phase is hereinafter defined.

(d) "Ultimate Phase" means that part of the Central Utah Project that has not yet been authorized by Congress, but does not include the Uintah Unit, which for the purpose of this agreement is deemed to be one of the features of the Initial Phase.

(e) "Kaiparowits Power Project" means the project proposed by the Companies to generate electricity at a coal-fired electric generating plant on the Kaiparowits Plateau in Kane County, Utah.

(f) "Companies" means Resources Company, a corporation organized under the laws of the State of Arizona and qualified to do business in the State of Utah, which is a wholly owned subsidiary of Arizona Public Service Company of Phoenix, Arizona; Associated Southern Investment Company, a corporation organized under the laws of the State of California and qualified to do business in the State of Utah, which is a wholly owned subsidiary of Southern California Edison Company of Los Angeles, California; and New Albion Resources Company, a corporation organized under the laws of the State of California and qualified to do business in the State of Utah, which is a wholly owned subsidiary of San Diego Gas & Electric Company of San Diego, California.

(g) "Bureau" means the Bureau of Reclamation, United States Department of the Interior.

(h) "Engineer" means the Utah State Engineer or that agency of the State of Utah charged with the adjudication of the appropriation of the public waters of the State of Utah.

(j) "Acre foot" means the quantity of water required to cover an acre to a depth of one foot and is equivalent to 43,560 cubic feet.

(j) "Application No. 35818" means Application to Appropriate Water No. 35818, as amended, in the name of the Companies, filed with the Engineer.

(k) "Applications of the District for the Initial Phase" as used herein means the applications to appropriate water in the name of the United States Bureau of Reclamation filed with the Engineer for the

Vernal, Bonneville, Upalco, Jensen and Uintah Units of the Initial Phcase of the Central Utah Project, being Applications Nos. 18043 (filed in part to provide water for the Bonneville Unit), 36638 (filed for Starvation Reservor, which is part of the Bonneville Unit), 36639 which was filed as a possible substitute for 18043 and 36638, 36642 (Upalco Unit), 36644 and 30416 (Uintah Unit), 17558 and 30415 (Jensen Unit), and applications for the Vernal Unit which is already fully constructed.

II

PRELIMINARY RECITALS

A. The District is charged with cooperation with the United States and agencies thereof to contract for and repay the costs of the authorized and presently planned units of the Central Utah Project, and

B. The Companies are the applicants under Application No. 35818 and propose the diversion and use of up to 102,000 acre feet of water each year from the Colorado River in connection with the Kaiparowits Power Project, as stated in that application, and

C. The parties to this agreement recognize that there exists during or as a result of low water years the possibility of conflict between the demands for water from the Colorado River for use in connection with the Kaiparowits Power Project, and

D. The parties are desirous of agreeing on principles and a plan respecting, as between the parties, the priorities for use of the Colorado River waters in the event of such conflict in order that both projects may be developed and that protests and litigation may be avoided and the parties are willing to enter the agreements and covenants stated herein.

III

AGREEMENT OF THE PARTIES

A. Priority of Initial Phase:

The right of the District to use Colorado River water from the particular rivers and tributaries described as points of diversion in the Applications of the District for the Initial Phase of the Central Utah Project, including the Uintah Unit, shall have priority over the right of the Companies to use Colorado River water for the Kaiparowits Power Project pursuant to Application No. 35818, provided, however, that the priority rights of the District granted by this paragraph for the Initial Phase under its Applications Nos. 18043, 36638, 36639, 36642, 36644 and 30416, combined, shall not exceed a total of 700,000 acre feet of diversions in any calendar year.

B. The Period of Years Through 2010, A.D.:

Through the year 2010, A.D., the use of water for the Kaiparowits Power Project shall have priority over the use of water for the Ultimate Phase of the Central Utah Project (except the Uintah Unit which for the purpose of this agreement is considered a part of the Initial Phase).

The District agrees that it will not proceed under the Ultimate Phase of the Central Utah Project to divert water to the extent that such diversions would prevent the Companies' use of 102,000 acre feet per annum through the year 2010, A.D. It is understood that the District does not guarantee that amount of water to the Companies against diversions by others and does not agree to curtail any diversions which the District would be authorized to make under Paragraph A above for the Initial Phase of the Central Utah Project, including the Uintah Unit.

C. The Period of Years After 2010, A.D., Through 2030, A.D.:

(i) The years after 2010, A.D., through 2020, A.D.:

During the period after the year 2010, A.D., through the year 2020, A.D., the right to use 82,000 acre feet of Colorado River water each year for the Kaiparowits Power Project shall have priority over the use of Colorado River water for the Ultimate Phase of the Central Utah Project. The right to use an additional 20,000 acre feet of Colorado River water each year during that period for the Kaiparowits Power Project shall be subordinate and junior in priority to the use of water by the Ultimate Phase of the Central Utah Project.

(ii) The years after 2020, A.D. through 2030, A.D.:

During the period after the year 2020, A.D., through the year 2030, A.D., the right to use 62,000 acre feet of Colorado River water each year for the Kaiparowits Power Project shall have priority over the use of Colorado River water for the Ultimate Phase of the Central Utah Project. The right to use an additional 40,000 acre feet of Colorado River water each year during that period for the Kaiparowits Power Project shall be subordinate and junior in priority to the use of water by the Ultimate Phase of the Central Utah Project.

D. The Period of Years After 2030, A.D.:

After the year 2030, A.D., the right to use Colorado River water for the Ultimate Phase of the Central Utah Project shall have priority over the right to use Colorado River water for the Kaiparowits Power Project.

E. Reversion to State of Utah:

The Companies agree that upon abandonment of the Kaiparowits Power Project their rights to use water pursuant to Application No. 35818 shall revert to the State of Utah. The Companies further agree that should the Companies elect not to submit proof of completion of works and application of the quantity of water covered by Application 35818 to beneficial use, then that quantity of water for which works are not completed or which is not put to beneficial use will, as provided in the Utah Water Appropriation Statute (Chapter 3, Title 73, Utah Code Annotated, 1953, as amended) revert to the State of Utah.

IV

LOCATION OF KAIPROWITS POWER PROJECT

The Companies agree not to transfer or otherwise use the water for purposes other than the Kaiparowits Power Project and agree that the Kaiparowits Power Project, if constructed, will be constructed in the State of Utah. The Companies further agree that they will encourage construction in the State of Utah of development related to the Kaiparowits Power Project.

V

USE OF AGREEMENT BY THE ENGINEER

The parties agree that the provisions of this agreement may be incorporated as conditions in any decisions of the Engineer on any applications to appropriate water filed by the parties to this agreement with the Engineer seeking to appropriate water from the Colorado River or its tributaries.

VI

ASSIGNMENT

The Companies may at any time assign this agreement and all rights and priviledges of the companies under this agreement shall inure to the benefit of their successors and assigns.

IN WITNESS WHEREOF, the parties have set their hand and seal the day and year first above written.

THE CENTRAL UTAH WATER
CONSERVANCY DISTRICT

ATTEST:

By____________________
Sterling D. Jones, Chairman

____________________ Secretary

RESOURCES COMPANY

ATTEST:

By____________________
Its VICE PRESIDENT

____
Secretary

ASSOCIATED SOUTHERN INVESTMENT
COMPANY

ATTEST:

By____________________
Its President

____
Asst Secretary

NEW ALBION RESOURCES COMPANY

ATTEST:

By____________________
Its VICE PRESIDENT

____
Secretary

APPENDIX I-5

Indian Deferral Agreement Dated September 20, 1965
(Contract No. 14-06-W-194)

Conformed Copy

Contract No. 14-06-W-194

AGREEMENT

THIS AGREEMENT made and entered into this 20th day of September, 1965, pursuant to the Act of June 17, 1902, and acts amendatory thereof and supplementary thereto, and particularly the Act of April 11, 1956 (70 Stat. 105), by and between the United States of America acting through the Bureau of Reclamation and Bureau of Indian Affairs, Department of Interior, the Ute Indian Tribe of the Uintah and Ouray Indian Reservation, organized pursuant to the provisions of the Indian Reorganization Act of June 18, 1934 (48 Stat. 984) as amended, and the Central Utah Water Conservancy District, a public corporation.

WITNESSETH:

WHEREAS, the Central Utah project is planned for development and construction in two phases, initial and ultimate, and

WHEREAS, the project includes three major units, Bonneville, Upalco and Uintah, all or a part of which involve the Uintah and Ouray Indian Reservation within the Uintah Basin, two of which, Bonneville and Upalco, are included in the initial phase and the Uintah in the ultimate phase, and

WHEREAS, there are approximately 36,450 acres of land served or to be served from the Duchesne River, Bonneville Unit; 33,450 acres of land served or to be served from the Lakefork River, Upalco Unit; and 39,648 acres of land served or to be served from the Uintah River, Uintah Unit, either owned by Indians or non-Indians, but all of which are supplied or are to be supplied with water through original Indian water rights, and

WHEREAS, the Indian water right land has been scheduled in five separate groups for identification purposes, described as group (1) for which a Federal Decree has been entered, 25,070 acres of which are served or to be served from the Lakefork River and 34,152 acres from the Uintah River; group (2) consisting of 18,613 acres designated by the Secretary of the Interior as a part of the Uintah Indian Irrigation Project, and for which a certificate has been issued by the State Engineer of Utah and served from the Duchesne River; group (3) consisting of 1,115 acres designated by the Secretary of the Interior as a part of the Uintah Indian Irrigation Project and served or to be served from the Duchesne River but for which no certificate has been issued by the State Engineer of the State of Utah; group (4) consisting of 1,400 acres of original Indian allotted land served or to be served from the Duchesne River; and group (5) consisting of 29,118 acres of practicably irrigable land presently not under irrigation, 15,242 acres of which are to be served from the Duchesne River, 8,380 acres to be served from the Lakefork River and 5,496 acres to be served from the Uintah River, and

WHEREAS, development of all of group (5) land is proposed to be deferred to the ultimate phase of the Central Utah project, and

WHEREAS, the United States, acting through the Bureau of Reclamation, intends to construct the Bonneville unit of the Central Utah project as a part of the initial phase, and

WHEREAS, there are approximately 36,450 acres of land on the Duchesne River, either owned by Indians or non-Indians, but all of which are supplied or are to be supplied with water through original Indian water rights, and

WHEREAS, part of the Bonneville unit water supply will be used to irrigate approximately 10,000 acres of Indian water right lands under the existing Duchesne Feeder Canal and Midview Reservoir in order to free Lakefork River water for use upstream on lands in the Moon Lake Project, and

WHEREAS, the Ute Indian Reservation was established on the 3rd day of October 1861, embracing all of the three Unit Areas as described in the third whereas clause hereof, with the reservation of then perfected water rights sufficient to satisfy the future as well as the present need of the Indian Reservation with enough water to irrigate all the practicably irrigable acreage of the Reservation, and

WHEREAS, approximately 15,242 acres of practicably irrigable land within the Uintah and Ouray Indian Reservation of said group (5) lands and within said Bonneville Unit Area are presently not under irrigation, and

WHEREAS, the Ute Indian Tribe of the Uintah and Ouray Indian Reservation, for the considerations and subject to the conditions hereinafter stated, is agreeable to defer the use of water on said 15,242 acres of land for development under the ultimate phase of the Central Utah project;

NOW, THEREFORE, in consideration of the mutual and dependent covenants and conditions herein contained, it is agreed by the parties hereto as follows:

1. That construction of the Bonneville unit of the Central Utah project, initial phase, as authorized by the Congress of the United States, and as planned by the Bureau of Reclamation, may proceed without objection, interference or claim adverse to the water requirements for such unit, as set out in the Duchesne River Area Study Committee, Duchesne River Land and Water Resource Review dated April 1962.

2. That use of water on 21,208 acres of Indian water right land in the Uintah Basin portion of the Bonneville unit, with the priority date of October 3, 1861, described as groups (2), (3), and (4) in said report dated April 1962, is recognized and confirmed.

3. That use of water for the 15,242 acres of Indian owned land, described as group (5) in said Study Committee Report dated April 1962, may be deferred at this time upon the condition that said lands be included in the ultimate phase of the Central Utah project, as hereinafter provided.

4. That deferment of the development of said group (5) lands for irrigation purposes is granted by said Ute Indian Tribe conditioned upon the full and complete recognition of the water rights of said tribe, with a priority date of 1861 in groups (1), (2), (3), (4) and (5) as described in the book of claims filed with the State Engineer, State of Utah, by the Ute Indian Tribe, without resort to litigation.

5. It is further understood and agreed that said deferment

shall neither constitute an abandonment by said tribe, nor be construed as consent to any further deferment of the right to the use of water for the 15,242 acres referred to in paragraph 3 above. If the ultimate phase of the Central Utah project is not completed sufficiently to supply said Indian water rights by the 1st day of January, 2005, equitable adjustment will be made in accordance with said reserved and perfected water rights of the tribe to permit the immediate Indian use of the water so reserved. It is agreed that the first day of January, 2005, shall be mutually considered as the maximum date of deferment and that all phases of the Central Utah project will in good faith be diligently pursued to satisfy all Indian water rights at the earliest possible date. Under no circumstances shall the fixing of such maximum deferment date be construed as an agreement or license to interpose the satisfaction of inferior water rights delaying the satisfaction of said deferred Indian rights, except where the orderly development and construction of the Central Utah project directly requires such deferment of said Indian rights to be supplied from the ultimate phase of said Central Utah project.

6. No Indian water rights, referred to herein, shall restrict the owner thereof to agricultural uses but such rights may be used for purposes other than agricultural, including but not limited to industrial, municipal and recreational uses.

7. That the use of water from the Duchesne River and its tributaries in the Bonneville unit area, unless otherwise agreed in writing, shall be subject (1) to a river headgate diversion allowance

of 4 acre-feet per acre annually and (2) shall be delivered generally in accordance with an ideal demand curve for irrigation purposes, except for the purposes described in paragraph 6 hereof.

8. That the point of diversion from the Duchesne River of the Wissiup, Leland and Ouray School canals be moved upstream by the Uintah Indian Irrigation Project to the point of diversion of the Duchesne Feeder Canal.

9. That facilities will be provided under the Colorado River Storage Act to mitigate for losses to fish, wildlife and recreation upon the lands of the Ute Indian Tribe of the Uintah and Ouray Reservation or of its members caused by the construction and/or operation of the Central Utah project. This provision shall not be construed as any limitation upon the acceptance or use of any benefits as may become available under enhancement provisions of said act.

10. That development of the Uintah Unit of the ultimate phase of the Central Utah project to provide storage of the runoff waters of the Uintah River and its tributaries, be programmed for early authorization and construction.

11. That Bottle Hollow Reservoir be investigated at an early date with a view of including the same as a storage facility of the Uintah Unit.

12. That the exchange of Duchesne River water under the existing Duchesne Feeder Canal and Midview Reservoir for Lakefork River water in order to free Lakefork River water for use upstream on lands in the Moon Lake Project shall not impair the 1861 priority of the

Ute Indian Tribe or its members either in flow or storage right, and such exchange shall not be construed as an exchange of water rights.

13. Nothing herein contained shall be construed as preventing the construction and use of facilities by the Ute Indian Tribe, the Uintah Indian Irrigation Project, or the United States for storage and use of water upon all Uintah Indian Irrigation Project lands not supplied from facilities constructed under the Central Utah project.

14. This agreement is subject to the approval of the Secretary of the Interior or his duly authorized representative.

UNITED STATES OF AMERICA

BUREAU OF RECLAMATION

By /s/ N. B. Bennett, Jr.
Acting Commissioner

BUREAU OF INDIAN AFFAIRS

By /s/ John O. Crow
Deputy Commissioner

UTE INDIAN TRIBE OF THE UINTAH &
OURAY RESERVATION

By /s/ Francis Wyasket
Chairman

CENTRAL UTAH WATER CONSERVANCY DISTRICT

By /s/ Sterling D. Jones
President

APPENDIX I-6

Memorandum Decision by the Utah State Engineer
Approving Water Right Application No. 35818 of
Resources Company, dated September 3, 1965

APPENDIX I-6

BEFORE THE STATE ENGINEER OF THE STATE OF UTAH

IN THE MATTER OF APPLICATION)
) MEMORANDUM DECISION
NO. 35818)

9/3/65

Application No. 35818 was filed by Resources Company, P. O. Box 2591, Phoenix, Arizona. When originally filed on January 15, 1964, it sought to appropriate 200,000 acre-feet of water at alternate points from Lake Powell on the Colorado River for consumptive use in a coal-fed steam-electric power generating plant having a maximum installed generating capacity of five million kilowatts (5,000,000 KW). Thirteen thousand five hundred second-feet of water was also to be diverted continuously and used for cooling purposes.

Notice of this requested appropriation was published in the Southern Utah News, Kanab, Utah, April 16, 23 and 30, 1964, and the Deseret News, Salt Lake City, Utah, April 6, 13 and 20, 1964. Formal protests were filed by the Bureau of Reclamation. A hearing regarding these protests was held at Salt Lake City, Utah, December 14, 1964. The location of the hearing was approved by the applicant.

Prior to this hearing an undivided one-third (1/3)interest in the filing was assigned to each of the following corporations: (1) Associated Southern Investment Company, 100 Long Beach Blvd., Long Beach, California, and (2) New Albion Resources Company, P. O. Box 168, San Diego, California, leaving 1/3 interest in the original applicant. The application has also been amended so that it now provides for the appropriation of 102,000 acre-feet of water from Lake Powell at a point 300 feet east of the SW Cor. Sec. 3, T43S, R4E, SLB&M, to be used for steam-electric power generation. No additional water is to be diverted strictly for cooling purposes as these requirements are included in the 102,000 acre-feet. Also, there is now no proposal to return water to the Lake.

At the hearing on December 14, 1964, representatives of the Utah State Department of Fish and Game withdrew that agency's protest upon the condition that certain requirements be met. These were outlined in a letter from the Department to Mr. M. C. Titus, Vice-President and General Manager of Resources Company dated November 20, 1964, as follows:

"1. That reasonable precautions are taken to exclude game fish from entering the water intake facilities;

"2. That disposition of the ash and fly ash be handled so these materials should not enter the lake."

Acceptance of these conditions was given in a letter by the applicants to the Fish and Game Department dated December 12, 1964, and was also expressed by two of the applicants' witnesses at the hearing.

The objections of the U. S. Bureau of Reclamation may be summarized from the formal written protest as follows:

"1. Lake Powell is formed by Glen Canyon Dam, constructed by the protestant as part of the Colorado River Storage Project pursuant to the Act of Congress dated April 11, 1956, (70 Stat. 105) at a cost of many millions of dollars. Any use of these facilities, including rights of access, or of the water stored therein will require an agreement with the United States.

"2. Because of the large quantity of water for consumptive use described in the application, approval of this application would have an adverse effect thereof on the ultimate Central Utah Project, the Juniper Project, and other projects now being considered by the Bureau of Reclamation, Department of the Interior which are of interest to the State of Utah, and the public at large."

At the hearing the applicants submitted considerable information concerning the availability of raw materials, proposed location of facilities, quantity of water required for various uses, availability of water considering other potential uses in Utah, estimated future power requirements of the service areas, and economic impact of such a project on the State. Interested parties were allowed until February 15, 1965, to submit written statements favoring or objecting to the project. The time was later extended to May 24, 1965. During this extended period, formal protests were received from the following organizations:

(1) Millard County Water Conservancy District
(2) Price River Water Improvement District
(3) Carbon Water Conservancy District
(4) Sanpete Water Conservancy District
(5) Board of County Commissioners of Sanpete County

Several letters and statements in support of this proposal have also been received. All of these protests and statements in support of Application No. 35818 have been given careful consideration.

From all of the above data it is our opinion that the proposal has engineering and financial feasibility and that approval of Application No. 35818 would be in the public interest provided certain requirements are met. We are particularly concerned about the possible future conflict between this power plant and the water needs for the Ultimate Phases of the Central Utah Project and other presented proposed but not authorized projects.

Recognizing this potential conflict and the possibility for scheduling of construction of the various projects, the applicant companies and the Central Utah Water Conservancy District have held several meetings in an attempt to arrive at a basis for agreement regarding this matter. On May 24, 1965, we received a copy of an agreement dated May 19, 1965, between the Central Utah Water Conservancy District and the applicant companies in which they appear to have resolved any differences. A copy of said agreement is attached to this Memorandum Decision as Appendix "A" and is, by reference, incorporated into this Decision.

This agreement has the effect of subordinating Application No. 35818 to filings held for various phases of the Central Utah Project with the exception of Application No. 36645, but also subordinates the use of all or part of the water under Application No. 35818 to Application No. 36645 after the year 2010 A.D.

Following receipt of this agreement a hearing was scheduled concerning those protests which were received during the extended period. In each case the protests were withdrawn with the understanding that the conditions set forth in the aforesaid agreement would be incorporated in the decision of this office.

It should be pointed out that the specific filings mentioned in the agreement are not all that is necessary to assure the successful completion of the Central Utah Project. There are other applications which were filed for the purpose of protecting existing uses within the Uintah Basin area which bear a priority subsequent to Application No. 35818. Unless these filings are given similar protection by subordination of Application No. 35818, existing users of water could be injured. Approval without such subordination would not be in the best public interest.

It is, therefore, ordered and Application No. 35818 is hereby APPROVED with a priority date of January 15, 1964, at 1:45 p.m. o'clock, subject to the following conditions:

1. The applicants shall take all reasonable precautions to prevent game fish from entering the intake facilities and to prevent ash, fly ash and other undesirable materials and poor quality water from

the power plant from returning to Lake Powell.

2. The applications listed below, covering existing uses of water in the Uintah Basin, shall have priority to use the number of acre feet of water in any one year required for the irrigation of 1,061 acres (but the priority shall not exceed an aggregate of 4,244 acre-feet in one year for all applicants as a group) over the use of water by the applicants under Application No. 35818:

App. No.	Applicant	Priority
28483	J. Willis Moon	11:00 a.m. Nov. 19,1964
28484	Ray Thomas	" " " "
28485	Ray D. Broadhead	" " " "
28486	Clarence C. & Margaret Wright	" " " "
28492	Theron Robb	" " " "
28532	Farm Creek Irrigation Co.	" " " "
28533	Myrthen Moon	" " " "
28548	Ray D. Broadhead	" " " "
28549	Kenneth L.Wilkinson	" " " "
28581	Rocky Point Ditch Co.	" " " "
36542	Central Utah Water Consv. Dist.	" " " "
36543	" " " " "	" " " "
36544	" " " " "	" " " "
36545	" " " " "	" " " "
36546	" " " " "	" " " "
36547	" " " " "	" " " "
36548	" " " " "	" " " "
36549	" " " " "	" " " "
36550	" " " " "	" " " "
36551	" " " " "	" " " "
36552	" " " " "	" " " "
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36558	" " " " "	" " " "
36559	" " " " "	" " " "
36560	" " " " "	" " " "
36561	" " " " "	" " " "
36562	" " " " "	" " " "
36563	" " " " "	" " " "
36564	" " " " "	" " " "
36565	" " " " "	" " " "
36637	" " " " "	" " " "
36640	Dry Gulch Irrigation Co.	10:30 a.m. Nov. 27,1964
36641	Dry Gulch Irrigation Co.	10:30 a.m. Nov. 27,1964

This paragraph does not fix the duty of the water and does not constitute approval of the named applications but is limited to establishing the relative priorities as between the named applicants and the applicants under Application No. 35818.

3. The rights of the applicants under the seven applications listed below filed for the Initial Phase of the Central Utah Project, including the Uintah Unit of that Project, shall, as between the uses covered by said applications and the uses covered by Application No. 35818, have priority over the rights under Application No. 35818, provided, however, that the priority rights under said applications shall not in the aggregate exceed 700,000 acre-feet of diversions in any calendar year.

App. No.	Applicant	Unit	Priority
36638	U.S.Bureau of Rec.	Starvation Res.	12:00 Noon Nov.19,1964
36639	" " " "	Bonneville Unit	" " " " "
36642	" " " "	Upalco Unit	11:00 a.m. Nov.27,1964
36644	" " " "	Uintah Unit	9:00 a.m. Nov.27,1964
30416	" " " "	Uintah Unit	10:05 a.m. Aug. 7,1958
17558	" " " "	Jensen Unit	3:30 p.m. Apr.23,1946
30415	" " " "	Jensen Unit	10:05 a.m. Aug. 7,1958

4. The relative priorities of Application No. 35818 and Application No. 36645 and any and all applications which may hereafter be filed to implement the Ultimate Phase of the Central Utah Project shall be as set forth in Paragraphs III B, C and D of that certain agreement dated May 19, 1965, attached hereto as Appendix "A", and all other conditions of said agreement are hereby incorporated as conditions of this approval by reference thereto.

5. A certain Agreement between the United States of America, acting through the Bureau of Reclamation and the Bureau of Indian Affairs of the Department of Interior, the Ute Indian Tribe of the Uintah-Ouray Reservation, organized pursuant to the provisions of the Act of June 18, 1934 (48 Stat. 984, as amended), and the Central Utah Water Conservancy District, a public corporation, was executed by the parties thereto and became effective on September 2, 1965, (said Agreement being referred to as the "Indian Deferral Agreement", a copy of which is attached hereto as Exhibit "B"). The applicants have, by letter dated August 31, 1965, a copy of which is attached hereto as Exhibit "C", recognized and acknowledged the priority of the rights of the Ute Indian Tribe to use Colorado River water to the extent of the irrigation requirements of the irrigable Indian water rights land described in the Indian Deferral Agreement and as set

forth in the said letter of August 31, 1965.

Therefore, the State Engineer APPROVES Application No. 35818 of Applicants, subject to said letter dated August 31, 1965.

6. The date for submitting Proof of Appropriation is hereby set for November 30, 1970. On or before this date the applicants are required to furnish to the State Engineer evidence that they have either commenced the construction or installation of facilities in connection with the first unit of the proposed power plant project or have let one or more of the contracts necessary to implement construction of the first unit. If such evidence has not been filed by that date, the State Engineer may give to the applicants notice to show cause why said application shall not be declared forfeited in whole or in part.

102,000

7. The applicants have indicated they have no intention of using water under this filing for any other purpose than for that described in the application. This approval is so conditioned that any part or all of the 120,000 acre-feet of water which is not used for the purposes specified in Application No. 35818 at the locations described in said application, or at changed locations approved as provided by law, shall be subject to use by other appropriators under their respective priorities.

8. The applicant companies should understand that this approval grants no easements or rights-of-way to obtain the water from Lake Powell and said companies must make any necessary arrangements with the appropriate agencies of the Federal Government to divert water from Lake Powell.

This decision is subject to all prior water rights and to the provisions of Section 73-3-14, Utah Code Annotated, 1954, which provides for plenary review by the filing of a civil action in the appropriate District Court within sixty days from date hereof.

Dated this 3rd day of September, 1965.

Hubert C Lambert
Hubert C. Lambert
ACTING STATE ENGINEER

RKH/HCL/pbs/le

APPENDIX I-7

Contract for Water Service from Lake Powell,
dated October 2, 1969 (Contract No. 14-06-400-5139

APPENDIX I-7

Contract No. 14-06-400-5139
Conformed Copy

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

GLEN CANYON UNIT
COLORADO RIVER STORAGE PROJECT
CONTRACT FOR WATER SERVICE FROM LAKE POWELL

THIS CONTRACT, made this 2nd day of October, 1969, pursuant to the Act of Congress approved June 17, 1902 (32 Stat. 388), and acts amendatory thereof or supplementary thereto, all of which acts are commonly known and referred to as the Federal Reclamation Laws and particularly pursuant to the Act of Congress approved April 11, 1956 (70 Stat. 105), between THE UNITED STATES OF AMERICA, hereinafter referred to as the United States, represented by the officer executing this contract, his duly appointed successor, or his duly authorized representative, hereinafter referred to as the Contracting Officer and RESOURCES COMPANY, a corporation of the State of Arizona and a subsidiary of Arizona Public Service Company, with its principal office at Phoenix, Arizona, ASSOCIATED SOUTHERN INVESTMENT COMPANY, a corporation of the State of California and a subsidiary of Southern California Edison Company, with its principal office at Long Beach, California, and NEW ALBION RESOURCES COMPANY, a corporation of the State of California and a subsidiary of San Diego Gas & Electric Company, with its principal office at San Diego, California, hereinafter collectively referred to as the Contractor.

WITNESSETH:

WHEREAS, the following statements are made in explanation:

(a) The United States has constructed Glen Canyon Dam and Reservoir forming Lake Powell as a part of the Colorado River Storage Project, hereinafter referred to as Storage Project, and water service from Lake Powell can be furnished for industrial purposes.

(b) The Contractor needs water service from Lake Powell for use in connection with a steam electric generating plant and related facilities known as the Kaiparowits Power Project, which it plans to construct in the vicinity of Lake Powell.

NOW, THEREFORE, in consideration of the mutual and dependent covenants herein contained, the parties hereto agree as follows:

TERM OF CONTRACT

1. This contract shall be effective on the date first above written and shall remain in effect for a period of forty (40) years commencing on January 1 of the year in which water is first taken from Lake Powell under this contract or January 1, 1977, whichever occurs first.

RENEWAL OF CONTRACT

2. The Contractor shall have the right to renew this contract for one period of not to exceed twenty (20) years by giving the United States one (1) year's written notice prior to the end of the initial period, and Contractor shall have the right to renew the contract for additional periods of not to exceed forty (40) years each by giving the United States one (1) year's written notice prior to the end of the then existing period. The initial renewal shall be subject to renegotiation only of the charges set forth herein giving consideration to the circumstances prevailing at the time of renewal as provided in the Act of June 21, 1963 (P.L. 88-44; 77 Stat. 68), and any renewal or renewals after the initial twenty (20) year renewal shall be on terms and conditions mutually agreeable to the parties pursuant to the provisions of the said Act.

TERMINATION OF CONTRACT

3. This contract or any renewal thereof pursuant to Article 2 may be terminated:

(a) By the United States upon failure of the Contractor to perform its obligations under this contract. The United States will give the Contractor notice in writing of its intention to terminate this agreement and said notice shall specify each failure of the Contractor, and shall further provide that the Contractor may, within a one hundred twenty-(120) day period from the date of said notice, present the Secretary a detailed program to correct such deficiencies, and the Secretary shall accept such program subject to such conditions as he may reasonably impose, and thereby waive the termination notice.

(b) By the Contractor upon advance written notice of at least two (2) years prior to the requested termination date.

NON-USE OF WATER

4. The United States shall have the right to withdraw water service for that quantity of water which is not used in accordance with the schedule provided for in Article 7 for any continuous period of five (5) years unless, however, (i) such non-use resulted

from failure of the United States to provide the requisite water service, or (ii) Contractor has been prevented from using water because of uncontrollable forces, or (iii) Contractor has exercised reasonable diligence to take water service to the fullest extent permitted, consideration being given to economic conditions and good utility management. In the event of withdrawal, the Contractor shall have no further payment obligation with respect to the water service withdrawn.

CONSTRUCTION AND OPERATION OF FACILITIES

5. All pumps, pipelines, storage tanks, reservoirs, flood control and wasteway canals, waste area dams and reservoirs and other facilities required to take, measure and convey water to points of use, and to return water to Lake Powell, or to dispose of wastes from points of use hereinafter collectively referred to as facilities, shall be constructed or installed, operated and maintained by the Contractor at its sole expense. It is specifically recognized and agreed that this contract does not grant to the Contractor rights-of-way for the Kaiparowits Power Project on lands of the United States, but the Contractor will obtain such rights by application to the Secretary pursuant to Section 10 of the Reclamation Project Act of 1939 (53 Stat. 1196, 43 U.S.C.A. 387), as amended or other appropriate authority.

AVAILABILITY OF WATER SERVICE

6. The United States will furnish the Contractor water service during the term of this contract by permitting the Contractor to take from Lake Powell water annually in the amounts specified in Article 7 at such times as best suits the Contractor's needs at the location established in the rights granted the Contractor pursuant to Section 10 of the Reclamation Project Act of 1939, referred to in Article 5, or other appropriate authority, and the Contractor shall pay for the water service as provided in Article 8. It is recognized that pending completion of preliminary engineering and design studies, the location of the diversion works and works for the return of water cannot be determined and the Contractor and Contracting Officer shall cooperate in obtaining location therefor. The water service furnished shall be used by the Contractor only for the Kaiparowits Power Project and other purposes related to the operation of said project including, but not limited to, fuel production and ash disposal. The Contractor shall have no holdover storage rights in Lake Powell from year to year, and relinquishes its claim to any annual water service not utilized by December 31 of each year. Any water deliverable hereunder that is not called for by December 31 of each year shall become part of the following year's Storage Project water supply and be available for all Storage Project purposes in such year. It is understood and agreed that any sale, gift, delivery or other disposition of the whole or any part of said water by the Contractor to third parties shall be subject to the provisions set forth in Article 24.

WATER SCHEDULE

7. The Contractor's right to water service from Lake Powell shall be in accordance with the following schedule:

Year	Water to be Taken (Acre-Feet)
1977	3,825
1978	19,125
1979	30,600
1980	30,600
1981	30,600
1982	34,425
1983	49,725
1984	61,200
1985	61,200
1986	61,200
1987	66,300
1988	86,700
1989 and for each successive year thereafter	102,000

(a) Provided that:

(i) Commencing with the year 2011 A. D., the furnishing of water service in excess of 82,000 acre-feet per year shall be subject to and subordinate to the call upon Utah's apportionment of water from the Colorado River and its tributaries pursuant to the Upper Colorado River Basin Compact for the Central Utah Project, Ultimate Phase;

(ii) Commencing with the year 2021, the furnishing of water service in excess of 62,000 acre-feet per year shall be subject to and subordinate to the call upon Utah's apportionment of water from the Colorado River and its tributaries pursuant to the Upper Colorado River Basin Compact for the Central Utah Project, Ultimate Phase; and

(iii) Commencing with the year 2031, the furnishing of any water service shall be subject to and subordinate to the call upon Utah's apportionment of water from the Colorado River and its tributaries pursuant to the Upper Colorado River Basin Compact for the Central Utah Project, Ultimate Phase.

(b) The Contractor may from time to time increase the quantities of water to be taken under the above schedule, up to the maximum of one hundred and two thousand (102,000) acre-feet, or up to any lesser maximum quantity as has resulted from any relinquishment pursuant to Article 7(c) or withdrawal pursuant to Article 4 hereof, by giving six (6) months' written notice to the United States.

(c) The Contractor shall have the right to relinquish permanently a portion of its right to water service provided by this contract by giving two (2) years' written notice to the United States stating the quantity of water service to be relinquished. In the event of such relinquishment the Contractor shall have no further payment obligation with respect to the water service relinquished.

RATE AND METHOD OF PAYMENT

8. (a) During the initial forty-(40) year period of this contract, the Contractor shall pay for water service hereunder at the rate of Seven Dollars ($7.00) per acre-foot as scheduled in Article 7 or as the schedule may be increased or partially relinquished as provided in said article. Payments shall be made quarterly in advance in four (4) equal payments on January 1, April 1, July 1, and October 1 of each year commencing with the quarter in which water service is first furnished hereunder or the first quarter of the calendar year 1977, whichever occurs first; provided, however, that the Contractor shall not take any water from Lake Powell for which the Contractor has not paid in advance. Should there be any curtailment in water service pursuant to the provisions of Articles 4, 7, 11, 12, 17, or 18, a proportional adjustment in payments will be made.

(b) The Contractor shall pay to the United States on execution of this contract and thereafter each year on the anniversary of the effective date of this contract, an annual "readiness to serve" charge of thirty cents (30¢) per acre-foot each year for all contracted water for which the Contractor is not required to pay the $7.00 per acre-foot annual charge. This charge shall be an earnest money deposit to secure and reserve for the Contractor the right to water service provided in this contract. The accumulated earnest money deposits on quantities of water for which the Contractor commences paying the $7.00 rate shall be credited to payments due on such quantities of water. Should the contract be terminated for any reason, the remaining uncredited earnest money deposits shall become the property of the United States.

INTEREST UPON DELINQUENCY IN PAYMENT

9. Upon each charge to be paid by the Contractor to the United States pursuant to this contract which shall remain unpaid after the same shall become due and payable, there shall be imposed interest at the rate of one-half of one percent (1/2%) per month of the amount of such delinquent charge from and after the date when the same became due and until paid, and the Contractor hereby agrees to

pay such interest; provided, that no interest shall be charged to the Contractor unless such delinquency continues for more than thirty (30) days; provided, further, that the United States reserves the right to withhold delivery of water at any time the Contractor is delinquent in payment beyond thirty (30) days.

MEASUREMENT AND RESPONSIBILITY FOR DISTRIBUTION

10. (a) The water to be furnished to the Contractor and the water to be returned to Lake Powell will be measured, delivered and returned by facilities constructed, operated and maintained by the Contractor, as approved by the United States, and such facilities so constructed, operated and maintained shall be accessible for inspection at all reasonable times by proper representatives of the United States. The Contractor agrees at its own expense to make any necessary arrangement for transportation of such water from Lake Powell to the place of use.

(b) The United States shall not be responsible for the control, carriage, handling, use or disposal of water furnished the Contractor hereunder, and the Contractor shall hold the United States harmless on account of damage or claim of damage of any nature whatsoever, including property damage, personal injury or death arising out of or connected with the Contractor's control, carriage, handling, use, disposal, or distribution of such water. The Contractor shall perform [illegible] all acts necessary in order to maintain control of water [illegible]able to the Contractor.

WATER SERVICE SUBJECT TO COMPACTS, ACTS AND TREATY

11. This contract and all water delivery pursuant thereto shall be subject to and controlled by the applicable provisions of Colorado River Compact dated November 24, 1922, and proclaimed by the President of the United States, June 25, 1929; the Boulder Canyon Project Act approved December 21, 1928; the Boulder Canyon Project Adjustment Act of July 19, 1940; the Upper Colorado River Basin Compact dated October 11, 1948; and the Mexican Water Treaty of February 3, 1944. In the event the amount of water service hereunder is required to be curtailed under and by reason of the provisions of the foregoing acts, no liability shall attach to the United States for such curtailment. The Contractor agrees to a reduction of the amount of water service hereunder as the Secretary determines necessary to comply with the provisions of Article IV of the Upper Colorado River Basin Compact; provided, that commencing at the time in any year that it is determined that diversions from Lake Powell for use in Utah must be curtailed in order to comply with the provisions in said Compact Article IV, the United States, insofar as is practicable, will curtail diversions by subsequent contractors to minimize the need to curtail water diversions by or for the Contractor, and provided, further, that in no event will water service to the Contractor be reduced so long

as subsequent contractors for water service are diverting water from Lake Powell for use in Utah.

MAINTENANCE OF WATER LEVELS IN LAKE POWELL

12. The United States will normally operate Lake Powell so that the water level is maintained above elevation 3490 feet above mean sea level. However, the United States shall not be responsible for the maintenance of any particular water level in Lake Powell in order to permit the Contractor to take water therefrom through the facilities which it installs in accordance with Article 5. Charges shall be due and payable as provided in Article 8 irrespective of the Contractor's inability to take water except that if the water level drops below elevation 3490 and the Contractor is unable to withdraw water, the annual payments referred to in Article 8 will be proportionately adjusted to reflect the quantity of water service unavailable to the Contractor.

NONRESPONSIBILITY OF THE UNITED STATES FOR QUALITY OF WATER

13. The operation and maintenance of project facilities and the construction of new project facilities for the provision of project water under this contract shall be performed in such a manner as is practicable to maintain the quality of raw water to be furnished hereunder. The United States is under no obligation to construct or furnish water treatment facilities to maintain or to better the quality of water except to the extent such facilities are expressly referred to elsewhere in this contract as part of the project facilities to be constructed by the United States pursuant to reclamation law or as otherwise required by law. The United States is pursuing a program of water quality control as a national policy pursuant to the Federal Water Quality Act of 1965 and other similar legislation, including the establishment of and compliance with water quality standards, and will actively promote, support, and encourage the improvement of quality of water furnished hereunder. The Contractor, however, agrees that the United States assumes no liability should the water furnished hereunder be unsuitable for the Contractor's purposes.

WATER POLLUTION CONTROL

14. (a) The Contractor shall have the right to return water from the Kaiparowits Power Project to Lake Powell at locations and under measurement procedures approved by the Secretary so long as the temperature of such water shall not average more than 90° F., for any 24-hour period.

(b) The Contractor agrees that it will comply fully with all applicable Federal and State laws, orders and regulations, all as administered by appropriate authorities, concerning the pollution of streams, reservoirs, ground water, or water courses with respect to thermal pollution or the discharge of refuse, garbage, sewage effluent, industrial waste, oil, mine tailings, mineral salts, or other pollutants.

(c) The Contractor shall cause to be installed and diligently operated as part of the plant facilities, waste water, waste material and sewage control and disposal facilities. Plans and designs for waste water, waste material and sewage disposal shall be submitted to the Secretary in advance of construction, installation, or major modification of facilities. The Secretary shall in writing approve of or object to such plans and designs within sixty (60) days after such submission. In the event any objection cannot be resolved by mutual agreement within ninety (90) days of such submission, the matter shall be submitted to arbitration in accordance with the provisions of Article 16.

(d) The Contractor further agrees that any contract it may enter into with a third party for the furnishing or use of project water will contain this article.

AIR POLLUTION CONTROL

15. (a) To minimize smoke, fly ash, and dust in stack emissions, the Contractor shall procure and cause to be installed as part of the plant facilities, equipment specified to have a design efficiency for removal of particulate matter of ninety-nine and five-tenths percent (99.5%): PROVIDED, HOWEVER, That if the technology at the time of such procurement makes it impracticable for qualified venders to meet such percentage with a commercially proven design, the Contractor shall be obligated to specify the highest percentage so proven at the time of such procurement. Such air pollution control equipment shall be operated so as to remove not less than ninety-seven percent (97%) of the particulate matter in the stack emissions in each month and not less than ninety-six percent (96%) thereof in any twenty-four (24) hour period, unless uncontrollable forces prevent such operation. Designs and plans for the air pollution control equipment, stack, and other plant features that may affect air pollution, and facilities for control and disposal of waste or residue from burned fuel shall be submitted to the Secretary in advance of construction, installation, removal, or major modification thereof. The Secretary shall in writing approve of or object to the aforesaid designs, plans, equipment or features or the major modification or supplementation thereof, within sixty (60) days of such submission. In the event any objection cannot be resolved by mutual agreement within ninety (90) days of such submission, the matter shall be submitted to arbitration in accordance with the

provisions of Article 16. In the event that the Secretary fails to act within sixty (60) days of such submission, the Secretary shall be deemed to have given his approval. The Secretary's approval of such designs and plans shall not be deemed by implication or otherwise to relieve the Contractor of the obligation to meet operating [illegible] set forth in this article. From time to time, but not [illegible] than once in every ten (10) years, the designated representatives of the Secretary and the Contractor will meet to review technological advances in air pollution control equipment and mutually weigh and decide upon the feasibility of installing additional equipment or modifying existing equipment in the plant facilities, taking into account cost as well as benefits of improved air pollution control.

(b) In the operation of the plant facilities utilizing the contracted water, the Contractor will make or cause to be made such tests and measurements and keep or cause to be kept such records as will enable the Contractor to make accurate and complete reports to the Secretary relating to the operation and efficiency of the air pollution control equipment. Said reports shall be furnished to the Secretary not less often than once in each calendar year. Any continuous recording equipment will be calibrated against test performed in conformance with American Society of Mechanical Engineers (ASME) Test Procedures for Determining Dust Concentration in a Gas Stream unless some other procedure for making such tests and measurements may be mutually agreed upon. Such test procedures will be conducted at least every six (6) months. Contractor shall also furnish the Secretary with monthly reports showing the average monthly assay of the ash and sulphur content of the coal used.

(c) During normal working hours, representatives of the Secretary shall have access to, the right to inspect, and to copy, all records relating to air pollution from the plant facilities, and such representatives shall have the right to enter upon and inspect such plant facilities and all parts thereof and appurtenances thereto.

(d) The thermal-electric generating plant facilities utilizing the water under this contract shall be fueled with Utah coal mined in the Kaiparowits field and/or the Kanab field, or derivaties therefrom, unless the Secretary approves the use of other coal and derivatives therefrom. The Contractor will furnish quantitative data on ash and sulphur content of said coal as a part of the design and plans referred to in Article 15(a). It is understood and agreed that natural gas and oil may be used as an auxiliary fuel in operating the thermal-electric generating plant utilizing water furnished under this contract.

(e) Nothing herein shall be construed to relieve the water user from complying with all valid, applicable air pollution control laws and regulations under Federal, State or County jurisdiction now or hereafter in force.

ARBITRATION

16. Whenever a controversy arises as to which arbitration is provided for and such controversy cannot be resolved by the Secretary and the Contractor, either of said parties by written notice to the other may require such controversy to be submitted to arbitration. Within thirty (30) days from the date of the notice the Secretary and the Contractor shall each name one arbitrator and the two arbitrators so selected shall within sixty (60) days from the date of said notice select a third arbitrator. In the event that either party has not appointed its arbitrator within the specified thirty-(30) day period, then the other party may make application to the appropriate United States District Court for Utah for the appointment of an arbitrator for the party failing to act. In the event of the failure of the two arbitrators to select the third arbitrator either the Secretary or the Contractor may make application to the appropriate United States District Court for Utah for the appointment of the third arbitrator substantially in accord with the procedure provided in the Federal Arbitration Act (9 U.S.C.A. 1). It is understood and agreed that the Secretary and the Contractor shall each bear the costs and expenses of its respective arbitrator, and the cost and expense of the third arbitrator together with all other costs and expenses incident to said arbitration shall be shared equally by the parties. The decision of any two of the three arbitrators shall be a valid and binding award of the arbitration. The arbitrators shall render a decision within one hundred and eighty (180) days of the time of submission of the controversy to arbitration. In event of a determination that arbitration is not binding on the United States, any matter referred to arbitration shall be referred to a court of competent jurisdiction.

UNCONTROLLABLE FORCES

17. Neither party shall be considered to be in default in respect to any obligation hereunder, if prevented from fulfilling such obligation by reason of uncontrollable forces, the term "uncontrollable forces" being deemed for the purposes of this contract, to mean any cause beyond the control of the party affected, including, but not limited to, drouth, failure of facilities, flood, earthquake, storm, lightning, fire, epidemic, war, riot, civil disturbance, labor disturbance, sabotage and restraint by court or public authority, which by exercise of due diligence and foresight, such party could not reasonably have been expected to avoid. Either party rendered unable to fulfill any obligation by reason of uncontrollable forces shall exercise due diligence to remove such inability with all reasonable dispatch.

UNITED STATES NOT LIABLE FOR WATER SHORTAGE

18. On account of uncontrollable forces, there may occur at times a shortage during any year in the quantity of water available for furnishing to the Contractor by the United States pursuant to this contract through and by means of the project, and in no event shall any liability accrue against the United States or any of its officers, agents or employees for any damage, direct or indirect, arising therefrom.

CONTRACTOR TO KEEP BOOKS AND RECORDS

19. The Contractor shall establish and maintain accounts and other books and records sufficient to enable it to furnish, and the Contractor will furnish to the Contracting Officer, upon his request, reports and statements as to the Contractor's operations pertaining to this contract.

INSPECTION OF BOOKS AND RECORDS

20. Subject to applicable Federal laws and regulations, the proper officers or agents of the Contractor shall have full and free access at all reasonable times to the Storage Project account books and official records of the Bureau of Reclamation, insofar as the same pertain to the matters and things provided for in this contract, with the right at any time during office hours to make copies thereof, and proper representatives of the United States shall have similar rights with respect to the account books and records of the Contractor as such pertain to this contract.

CONTINGENT UPON APPROPRIATIONS OR ALLOTMENTS OF FUNDS

21. The expenditure of any money or the performance of any work by the United States herein provided for which may require appropriations by the Congress or the allotment of funds shall be contingent upon such appropriations or allotments being made. The failure of the Congress to appropriate funds or the failure of an allotment of funds shall not relieve the Contractor from any obligations under this contract except as otherwise provided herein, and no liability shall accrue to the United States in the event such funds are not so appropriated or allotted.

REMEDIES - WAIVERS

22. Nothing contained in this contract shall be construed as in any manner abridging, limiting or depriving either party to this contract of any means of enforcing any remedy, either at law or in equity, for the breach of any of the provisions hereof which it would otherwise have, provided, prior notices as herein agreed have been given. Any waiver at any time by either party to this contract of

its rights with respect to any default, or any other matter arising in connection with this contract, shall not be deemed to be a waiver with respect to any subsequent default or matter.

OFFICIALS NOT TO BENEFIT

23. No Member of or Delegate to Congress or Resident Commissioner and no officer, agent, or employee of the United States Department of the Interior shall be admitted to any share or part of this contract or to any benefit that may arise herefrom, but this restriction shall not be construed to extend to this contract if made with a corporation or company for its general benefit.

ASSIGNMENT LIMITED: SUCCESSORS AND ASSIGNS OBLIGATED

24. The provisions of this contract shall apply to and bind the successors and assigns of the respective parties, but no voluntary assignment or transfer of this contract or any part thereof or interest therein shall, except as hereinafter provided, be valid unless and until approved by the Contracting Officer. Upon any transfer of interest as to which approval by the Contracting Officer is not required or in the case of any transfer which shall have been approved by the Contracting Officer, such company or companies comprising the Contractor which have effected such transfer of interest shall no longer be obligated to the United States to keep and perform the conditions and covenants in this contract on their part to be kept and performed insofar as such obligations have been transferred, except in the case of any transfer which results as a consequence of the enforcement of rights conferred by trust indentures, mortgages, trust deeds, security agreements or other instruments for purposes of security, as provided below:

The execution of trust indentures, mortgages, trust deeds, security agreements or other instruments for purposes of security, or trustee's sale made thereunder, and the transfer and assignment of interests in this agreement to a trustee or trustees under such trust indentures, mortgages, deeds of trust, security agreements or other instruments for purposes of security, and to any successors or assigns thereof, or any receiver, referee or trustee in bankruptcy or receivership or reorganization of any of the companies comprising the Contractor, or any successor by action of law, or any purchaser, transferee or assignee of any thereof, shall not be deemed to be a voluntary transfer within the meaning of this section and shall not require approval by the Contracting Officer. Any trustee, successor or assignee of the rights of any of the companies comprising the Contractor, whether by voluntary transfer or otherwise, shall be subject to all provisions and conditions of this contract to the same extent as though the transferee, successor or assignee were an original Contractor hereunder, except that any such trustee, successor or assignee who succeeds to the interest of any company comprising the Contractor as a consequence of the enforcement of rights conferred by any trust indenture, mortgage, trust deed, security agreement or other instrument for purpose of security executed by such company or its predecessor in interest shall not be liable for any obligation to pay money owing under this contract by such company which obligation arose prior to the date on which any such trustee, successor or assignee succeeds to the interest of such company, and the interest of such successor shall not be subject to any such obligation to pay money owing, but any such obligation shall be and remain the obligation of such company.

Each of said companies comprising the Contractor shall have the right to transfer or assign in whole or in part its interests in this contract, without need for consent of the United States, at any time (i) to any of the other company or companies constituting the Contractor hereunder, or (ii) to the parent companies of which said companies are subsidiaries. In addition, each of said companies comprising the Contractor shall have the right to transfer or assign an undivided interest in this contract without need for consent of the United States at any time to any corporation, cooperative or political subdivision or public agency participating with the Contractor in the ownership and operation of the Kaiparowits Power Project, including, but not limited to, the production, processing or transportation of fuel therefor. Any such successor shall become subject to all the obligations of the transferor or assignor company hereunder and any such transferor or assignor shall notify the United States of such transfer, assignment or reassignment and shall furnish the United States evidence of such transfer, assignment or reassignment.

The companies comprising the Contractor shall not receive any valuable consideration for any assignment in excess of previous payments by the Contractor to the United States for rights to water delivery which have not been used and which are assigned to the assignee. The Contractor shall not exact any brokerage, commission, or fee from any person on the assignment of any rights to water delivery under this contract. In connection with any assignment, the President or Chairman of the Board of the company making the assignment shall certify to the Contracting Officer that the assignment with respect to water delivery was without consideration except as provided above, and that no brokerage, commission, fee, or other charge of any kind was charged to the assignee or any person acting on behalf of the assignee on account of such assignment. The Contractor shall maintain books, records, documents, and all other evidence pertaining to any assignment of rights under this contract, and the Contracting Officer shall have access to and the right to examine any books, records, documents or other evidence of the Contractor involving any transaction, including assignment, related to this contract.

NOTICES

25. (a) Any notice authorized or required to be given to the United States shall be deemed to have been given when mailed, postage prepaid, or delivered to the Regional Director, Region 4, Bureau of Reclamation, United States Department of the Interior, P. O. Box 11568, Salt Lake City, Utah 84111. Any notice authorized or required to be given to the Contractor shall be deemed to have been given when mailed, postage prepaid, or delivered to Vice President and General Manager, Resources Company, P. O. Box 20824, Phoenix, Arizona 85036.

(b) The designation of the addressee or the address given above may be changed by notice in the same manner as provided in this article for other notices.

EQUAL OPPORTUNITY

26. The provisions of Title 42 U.S.C. 2000-e-2(i) provide for the giving of preference to Indians in employment. Except as therein provided and in keeping with any obligation undertaken or which may be undertaken by any of the corporations comprising the Contractor, or their assignees, pursuant to the terms of said Title 42 U.S.C. 2000-e-2(i) to give preference for employment to qualified Indians for work on or near an Indian Reservation during the performance of this contract the Contractor agrees as follows:

(a) The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex or national origin. Such action shall include, but not be limited to the following: Employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places available to employees and applicants for employment, notices to be provided by the Contracting Officer setting forth the provisions of this Equal Opportunity clause.

(b) The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex or national origin.

(c) The Contractor will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency Contracting Officer, advising the labor union or workers' representative of the Contractor commitments under the Equal Opportunity clause, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(d) The Contractor will comply with all provisions of Executive Order No. 11246 of September 24, 1965, and of the rules, regulations and relevant orders of the Secretary of Labor.

(e) The Contractor will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to its books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations and orders.

(f) In the event of the Contractor's noncompliance with the Equal Opportunity clause of this contract or with any of the said rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(g) The Contractor will include the provisions of the paragraphs (a) through (g) in every subcontract or purchase order unless exempted by rules, regulations or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No.11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions; including sanctions for noncompliance; Provided, however, that in the event the Contracto becomes involved in, or threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

UNITED STATES OPTION TO PARTICIPATE IN KAIPAROWITS POWER PROJECT

27. (a) The United States shall have the option to acquire an entitlement to a portion of the thermal generating capacity of the Kaiparowits Power Project, including an entitlement to transmission capacity for delivery of power and energy therefrom to the Central Arizona Project on terms and conditions to be negotiated in good faith by the proposed participants in the Kaiparowits Power Project, including the United States. The purpose of this option is to enable the United States to acquire all the power and energy or a portion thereof necessary to supply the Central Arizona Project pumping requirements, in accordance with the provisions of Section 303 of the Colorado River Basin Project Act (Public Law 90-537), in the event the United States has not, by the time the Kaiparowits Power Project is to be constructed, acquired such power and energy from another source.

(b) No water shall be delivered under this contract until either (i) the United States has acquired a supply of power and energy sufficient to supply the Central Arizona Project pumping requirements from a source other than the Kaiparowits Power Project; or (ii) an agreement has been executed that includes the United States as a participant in the Kaiparowits Power Project in accordance with Section 303 of the Colorado River Basin Project Act (Public Law 90-537); or (iii) the United States has been invited to join in good faith negotiations of such an agreement and has declined to do so. Such invitation shall not be made earlier than eighteen (18) months following execution of this contract and the United States shall respond within three (3) months after receiving said invitation. If a determination of feasibility has not been completed by June 1972, the Contractor shall advise the United States of the estimated completion date of said determination and the estimated date of on-line operation of the Kaiparowits Power Project.

IN WITNESS WHEREOF, the parties hereto have signed their names the day and year first above written.

THE UNITED STATES OF AMERICA

By /s/ Walter J. Hickel
Secretary of the Interior

RESOURCES COMPANY

ATTEST:

/s/ Wm. T. Quinsler
Secretary

By /s/ M. C. Titus
Vice President and General Manager

(SEAL)

ASSOCIATED SOUTHERN INVESTMENT COMPANY

ATTEST:

/s/ J. C. Bobek
Secretary

By /s/ J. K. Horton
Vice President

(SEAL)

NEW ALBION RESOURCES COMPANY

ATTEST:

/s/ W. A. Zitlau
Vice President and Treasurer

By /s/ W. A. Zitlau
Vice President and Treasurer

(SEAL)

APPENDIX I-8

Kaiparowits and Navajo Mutual Assistance Agreement
Between the United States of America and
San Diego Gas & Electric Company and
Southern California Edison Company
dated October 2, 1969
(Contract No. 14-06-400-5160)

Conformed Copy
Contract No. 14-06-400-5160

KAIPAROWITS AND NAVAJO MUTUAL ASSISTANCE AGREEMENT BETWEEN THE UNITED STATES OF AMERICA AND SAN DIEGO GAS & ELECTRIC COMPANY AND SOUTHERN CALIFORNIA EDISON COMPANY

1. THIS AGREEMENT made as of the 2nd day of October, 1969, between the UNITED STATES OF AMERICA, party of the first part (hereinafter called the United States), acting through the Secretary of the Interior (hereinafter called the Secretary), or his duly authorized representative, and SAN DIEGO GAS & ELECTRIC COMPANY, a California corporation (hereinafter sometimes called San Diego) and SOUTHERN CALIFORNIA EDISON COMPANY, a California corporation (hereinafter sometimes called Edison), parties of the second part (hereinafter sometimes called collectively Companies and individually Company).

2. WHEREAS, the United States intends to acquire an entitlement to capacity in coal-fired steam electric generating units under the terms of Section 303 of the Colorado River Basin Act (PL 90-537) and it is expected that such units will be part of a power plant proposed to be built by others and to be known as the Navajo Project; and

3. WHEREAS, the Companies with others intend to construct a coal-fired steam electric generating plant in southern Utah to be known as the Kaiparowits Project; and

4. WHEREAS, the United States and Companies intend to provide mutual assistance in times of unit outages at the Kaiparowits and Navajo Projects through the exchange of capacity and associated energy between the first three generating units of the Navajo Project and the first three generating units of the Kaiparowits Project.

5. NOW, THEREFORE, in consideration of the mutual covenants herein contained, the parties hereto agree as follows:

6. The United States shall have the option to participate in mutual assistance with Companies under conditions hereinafter provided through the exchange of capacity and associated energy to be supplied from the capacity entitlement of the United States in one or more of the first three generating units of the Navajo Project with capacity and associated energy to be supplied from the capacity entitlements of the Companies in one or more of the first three generating units of the Kaiparowits Project. Such option may be exercised only in the event (i) one or more generating units are constructed at the Navajo Project, and the United States has an entitlement to capacity in such unit or units, and (ii) Companies notify United States pursuant to paragraph 7 that one or more generating units are to be constructed by Companies at the Kaiparowits Project and the United States does not elect to exercise the option contained in Article 27 of Contract No. 14-06-400-5139 to acquire an entitlement to a portion of the thermal generating capacity in the Kaiparowits Project.

7. The Companies will notify the United States in advance of making commitments for the construction of each of the first three generating units at Kaiparowits Project and United States shall have six (6) months following the time of such notification within which to exercise the above mentioned option with respect to that unit, provided that no such notification by Companies shall be given prior

to June 1, 1971.

8. If the United States exercises the option acquired by it hereunder, a mutual assistance contract shall be negotiated in good faith between the United States and Companies, and shall provide, in addition to the usual terms and conditions of such a contract, for an exchange of capacity and associated energy, upon substantially the following terms and conditions:

(a) Capacity and energy acquired by the United States through such mutual assistance shall only be used for purposes permitted by Section 303 of the Colorado River Basin Act (PL 90-537).

(b) Whenever one or more of the Designated Navajo generating units is out of service due to a forced outage or scheduled outage for necessary maintenance, the United States shall be entitled to schedule capacity and associated energy from the Companies' entitlement in the Kaiparowits Project during each hour of such outage, and to receive such capacity and energy at mutually agreed upon delivery points in amounts equal to the product of the Mutual Assistance Percentage times the amount of capacity and associated energy it would be entitled to have generated for its account on such unit or units as are out of service at the Navajo Project, reduced, however, by the proportion by which the aggregate capacity entitlement of the Companies in the Designated Kaiparowits generating units is curtailed or out of service at the time.

(c) Whenever one or more of the Designated Kaiparowits generating units is out of service due to a forced outage or scheduled outage for necessary maintenance, the Companies shall be entitled to schedule capacity and associated energy from the United States' entitlement in the Navajo Project during each hour of such outage, and to receive such capacity and associated energy at mutually agreed upon delivery points in amounts equal to the product of the Mutual Assistance Percentage times the amount of capacity and associated energy which the United States would be entitled to have generated for its account on such number of units at the Navajo Project, reduced, however, by the proportion that the capacity entitlement of the United States in the Designated Navajo units is curtailed or out of service at the time.

(d) San Diego and Edison shall be obligated to provide capacity and associated energy to the United States pursuant to paragraph 8(b) hereof in the proportion that their individual capacity entitlements, if any, in the Designated Kaiparowits generating units in service at that time bears to the combined capacity entitlements of the Companies in such units. San Diego and Edison shall be entitled to receive capacity and associated energy from the United States pursuant to paragraph 8(c) hereof in the proportion that their individual capacity entitlements, if any, in the Designated Kaiparowits generating units out of service at that time bears to the combined capacity entitlements of the Companies in such units.

(e) The United States shall be obligated to pay San Diego and Edison monthly for the fuel cost incurred by each Company in the generation at Kaiparowits and transmission of the energy which the United States has received hereunder from such Company during the preceding month.

(f) Each Company shall be obligated to pay the United States monthly the fuel cost incurred by the United States in the generation at Navajo and transmission of the energy which it has received hereunder from the United States during the preceding month.

(g) The "Designated" units referred to in this Agreement shall be either: (i) The first three units constructed and placed in commercial operation at the Navajo Project in which the United States has a capacity entitlement and the first three units constructed and placed in commercial operation at the Kaiparowits Project in which one or both of the Companies has a capacity entitlement, or (ii) Prior to the time that there are three such units at both of the Projects, the "Designated" units shall consist of the units in the Project having the lesser number of such units and an equal number of units, specifically designated in the Project having the greater number of such units by the party or parties having a capacity entitlement therein. Such designation may only be changed by mutual agreement.

(h) If the combined capacity entitlement of the Companies in the Designated units of the Kaiparowits Project is less than the combined capacity entitlement of the United States in the Designated units of the Navajo Project then, for purposes of this paragraph 8, the capacity entitlement of the United States in the Designated units of the Navajo Project shall be deemed to be equal to the capacity entitlement of the Companies in the Designated units of the Kaiparowits Project.

(i) If the United States exercises the option acquired by it hereunder, the parties hereto shall, at the time of first exercising such option, select the "Mutual Assistance Percentage" which, unless otherwise agreed to, shall not exceed 50% and shall not be less than 15% and shall not thereafter be changed. Such Mutual Assistance Percentage shall be applicable to both subparagraphs 8(b) and 8(c). If the United States enters into mutual assistance agreements or similar agreements with others, the United States shall not therein commit capacity or associated energy from its entitlement in the Designated units at the Navajo Project, which when totaled and added to the capacity and associated energy committed by it pursuant to the exercise of this option, would exceed one-half of the United States' entitlement in such Designated units.

(j) The mutual assistance contract shall not be effective prior to the date of first pumping on the Central Arizona Project and thereafter shall not apply to a Company while it is receiving an assignment of capacity and energy from the United States' entitlement in the Navajo Project.

9.1 In consideration of the option provided to the United States in Article 27 of Contract No. 14-06-400-5139, to acquire an entitlement in a portion of the thermal generating capacity of the Kaiparowits Project and the option provided to the United States under this Agreement to enter into a mutual assistance contract with the Companies, the Secretary hereby finds that such options are more advantageous to the United States than the obligations provided for in 43 CFR 2234.1-3(c) (13) and 2234.4-1(c) (5) (ii); 36 CFR 251.52(d) (2); 25 CFR 161.27(f) (2); F.R. Doc. 67-3666, filed April 3, 1967, 32 F.R. 5520. Neither Company shall be required to include in any application for a grant of a right of way for facilities to be used in transmitting capacity and energy from the Kaiparowits Power Project to its respective load center, nor shall there be included in any grant of right of way issued for facilities to be used in transmitting capacity and associated energy from the Kaiparowits Project to the load centers of the Companies, any stipulation, covenant or obligation provided for in 43 CFR 2234.1-3(c) (13) and 2234.4-1(c) (5) (ii); 36 CFR 251.52(d) (2); 25 CFR 161.27(f) (2); F.R. Doc. 67-3666, filed April 3, 1967, 32 F.R. 5520, as such provisions now exist or are hereafter amended or superseded, or any similar stipulation, covenant or obligation. The Secretary will not require to be retained in any prior application of San Diego or Edison and will modify any prior grant applicable to rights of way for facilities to be used in transmitting capacity and associated energy from the Kaiparowits Power Project so as to eliminate from said applications and grants applicable to said rights of way for the terms of said grants, any stipulation, covenant or obligation provided for in the above mentioned regulation.

9.2 As used in paragraph 9.1, the phrase "facilities to be used in transmitting power and energy" shall be those transmission lines and related facilities constructed, reconstructed or relocated prior to January 1, 1990, for operation at 115 kv or above which will transmit power and energy from the Kaiparowits Power Project to the load centers of the Companies, or may be desirable or necessary to make the transmission of such power and energy reliable in accordance with good utility practices.

10. This Agreement will be governed by the law of the State of California and applicable Federal law.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed as of the day and year first above written.

THE UNITED STATES OF AMERICA

By /s/ Walter J. Hickel
Secretary of the Interior

ATTEST:

/s/ C. Hayden Ames
Assistant Secretary

(SEAL)

SAN DIEGO GAS & ELECTRIC COMPANY

By /s/ W. A. Zitlau
Executive Vice President

ATTEST:

/s/ J. C. Bobek
Assistant Secretary

(SEAL)

SOUTHERN CALIFORNIA EDISON COMPANY

By /s/ J. K. Horton
Chairman of the Board

APPENDIX I-9

Kaiparowits Power Coordination Contract,
Dated October 2, 1969
(Contract No. 14-06-400-5161

APPENDIX I-9

Contract No. 14-06-400-5161

Conformed Copy

UNITED STATES
DEPARTMENT OF THE INTERIOR
KAIPAROWITS POWER COORDINATION CONTRACT

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1. This contract, made as of the 2nd day of October, 1965, between THE UNITED STATES OF AMERICA, party of the first part (hereinafter called the "United States"), acting through the Secretary of the Interior (hereinafter called the "Secretary"), or his duly authorized representative, and ARIZONA PUBLIC SERVICE COMPANY, an Arizona corporation; SAN DIEGO GAS & ELECTRIC COMPANY, a California corporation; SOUTHERN CALIFORNIA EDISON COMPANY, a California corporation; parties of the second part (hereinafter called the non-Federal Parties),

2. WHEREAS, the parties hereto desire to coordinate, as hereinafter provided, the thermal-electric systems of the non-Federal Parties with the Colorado River hydroelectric system of the United States; and

3. WHEREAS, the United States, acting through the Secretary of the Interior or his duly authorized representative, is authorized to enter into arrangements for the marketing of electric power pursuant to the Federal Reclamation laws (Act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof and supplementary thereto); and

4. WHEREAS, the parties hereto have been negotiating the terms and conditions of an agreement whereby among other things the non-Federal Parties would sell to the United States energy to firm up the hydroelectric facilities of the Colorado River Storage Project and

the Parker-Davis projects and whereby the non-Federal Parties would purchase from the United States surplus energy from said hydroelectric facilities. However, due to the complexity of the problems with respect thereto, the parties have not, as of the date of execution of this contract, been able to reach agreement on all matters with respect thereto, and while the parties hereto are willing to continue negotiations in an effort to reach agreement on all matters with respect thereto on or before July 1, 1970, the parties desire to enter into this contract.

5. NOW, THEREFORE, in consideration of the mutual covenants herein contained, the parties hereto agree as follows:

ARTICLE 6

SALES AND PURCHASES OF ENERGY

6.1 Should a non-Federal Party desire to purchase energy from the United States at the point or points of delivery to be agreed upon by authorized representatives of the non-Federal Party and the United States, the United States agrees to supply such amounts of energy as the United States in its sole judgment desires to sell and the non-Federal Party desires to purchase.

6.2 Should the United States desire to purchase energy from a non-Federal Party at the point or points of delivery to be agreed upon by authorized representatives of the United States and the non-Federal Party, said Party agrees to supply such amounts of energy as the non-Federal Party in its sole judgment desires to sell and the United States desires to purchase.

6.3 The United States and any non-Federal Party may enter into transactions for the interchange of energy. A record of energy interchanges shall be maintained by each party to any such transaction and no energy deliveries by one party to the other party shall be deemed to be interchange energy unless prior agreement for such deliveries has been made between the authorized representatives of the parties to the transaction. Unless otherwise agreed by the authorized representatives of the parties to the transaction, the interchange energy account shall be balanced by return on a kilowatt-hour for kilowatt-hour basis as promptly as circumstances permit. The authorized representatives of the parties to such interchange transactions shall agree in advance of any such transactions on the terms for settling unbalanced accounts.

6.4 All deliveries of energy pursuant to this Article 6 shall be at such times, rates, and points of delivery and such conditions as may be mutually agreed upon by the parties to the transaction and shall be interruptible without notice.

ARTICLE 7

RATES

7.1 All charges for energy pursuant to Articles 7.2 and 7.3 hereof shall be adjusted for transmission costs and for any applicable governmental impositions or taxes.

7.2 The rate for energy sold by a non-Federal Party to the United States pursuant to Article 6.2 hereof shall be 115% of the incremental production cost to the selling non-Federal Party of such energy delivered to the point or points of delivery, as quoted to the

United States from time to time by that non-Federal Party prior to the delivery of the energy, or at such other time as may be mutually agreed to by the United States and the selling non-Federal Party. The incremental production cost shall be the estimated expense incurred by the selling non-Federal Party in generating the energy required to make such sale which expense shall be the sum of the following items divided by the number of kilowatt-hours of energy sold:

7.2.1 The estimated replacement cost of fuel used to generate the energy required to make such sale, plus

7.2.2 For operation and maintenance, 0.2 mills per kilowatt-hour of energy generated, plus

7.2.3 The estimated cost of making ready, starting up and shutting down such units as would necessarily be started to make such sale, including the estimated cost of zero net-load fuel.

7.3 The rate for energy sold by the United States to a non-Federal Party pursuant to Article 6.1 hereof shall be 85% of the decremental production value to the purchasing non-Federal Party of such energy at the point or points of delivery, as quoted to the United States from time to time by that non-Federal Party prior to the receipt of the energy, or at such other time as may be mutually agreed to by the United States and the purchasing non-Federal Party. The decremental production value shall be the estimated expense which would otherwise have been incurred by the purchasing non-Federal Party in generating energy in place of such purchase, which value shall be the sum of the following items divided by the number of kilowatthours of energy purchased:

7.3.1 The estimated replacement cost of fuel which would have been used to generate energy in place of such purchase, plus,

7.3.2 For operation and maintenance, 0.2 mills per kilowatthour of energy which would have been generated, plus,

7.3.3 The estimated cost of making ready, starting up and shutting down such units as would necessarily have been started to make the replaced energy available, including the estimated replacement cost of zero net-load fuel.

ARTICLE 8

NONDEDICATION OF FACILITIES

8.1 Any non-Federal Party, prior to entering into transactions with the United States hereunder, shall have made transmission arrangements satisfactory to it necessary for such transactions.

8.2 This contract shall not be construed to grant the non-Federal Party any rights of ownership in, or possession of, or control over the electric system of the United States.

8.3 This contract shall not be construed to grant the United States any rights of ownership in, or possession of, or control over the electric system of any non-Federal Party.

8.4 The non-Federal Parties do not intend to dedicate, and nothing in this contract shall be construed as constituting a dedication by any non-Federal Party of its properties or facilities or any part thereof, to the United States or to any other non-Federal Party, or to the customers of the United States or to the customers of any other non-Federal Party.

ARTICLE 9

BILLING AND PAYMENTS

9.1 The accounting period for all transactions entered into pursuant to this contract shall be one (1) month. The closing date shall be as mutually agreed to between the United States and the non-Federal Parties. Unless otherwise mutually agreed, bills for amounts payable for any month shall be submitted by the supplying party at the close of each billing period and such bills shall be due and payable within thrity (30) days following receipt of such bill.

ARTICLE 10

TERM OF CONTRACT

10.1 This contract shall become effective when it has been duly executed and delivered by all of the parties hereto; and shall remain in effect until December 31, 2026.

ARTICLE 11

RIGHTS-OF-WAY

11.1 If the United States participates in the Kaiparowits Project as provided for in Article 27 of Contract No. 14-06-400-5139, the Secretary hereby finds that the provisions hereof are more advantageous to the United States than the obligations provided for in 43 CFR 2234.1-3(c)(13) and 2234.4-1(c)(5)(ii); 36 CFR 251.52(d)(2); 25 CFR 161.27(f)(2); F. R. Doc. 67-3666, filed April 3, 1967, 32 F. R. 5520. Therefore, if the United States participates, during the term of this contract, no non-Federal Party shall be required to include in any application for a grant of a right-of-way for facilities to be used in transmitting power and energy from the Kaiparowits Power Project to their respective load centers, nor shall there be included in any grant of right-of-way issued pursuant to such an application, any stipulation, covenant or obligation provided for in 43 CFR 2234.1-3(c)(13) and 2234.4-1(c)(5)(ii); 36 CFR 251.52(d)(2); 25 CFR 161.27(f)(2); F. R. Doc. 67-3666, filed April 3, 1967, 32 F.R. 5520; as such provisions now exist or are hereafter amended or superseded, or any similar stipulation, covenant or obligation. The Secretary, upon the effective date of this contract, will also not require to be retained in any application and will modify any grant applicable to rights-of-way for facilities to be used in transmitting power and energy from the Kaiparowits Power Project filed or granted prior to the effective date of this contract so as to eliminate from said applications and grants applicable to said rights-of-way for the terms of said grants, any stipulation, covenant, or obligation provided for in the above-mentioned regulations.

11.2 As used in this Article 11, the phrase "facilities to be used in transmitting power and energy" shall be those transmission lines and related facilities constructed, reconstructed or relocated prior to January 1, 1990, for operation at 115 kv or above which will transmit power and energy from the Kaiparowits Power Project to the load centers of the non-Federal Parties, or which may be desirable or necessary to make the transmission of such power and energy reliable in accordance with good utility practice.

ARTICLE 12

OBLIGATIONS SATISFIED

12.1 This contract, together with the option provided to the United States in Article 27 of Contract No. 14-06-400-5139 to participate in the Kaiparowits Power Project, fulfills and satisfies any and all obligations that the United States and any non-Federal Party and any subsidiary thereof may have arising out of the exchange of correspondence between the Secretary of the Interior and the President of Southern California Edison Company, dated April 7, 1966, and April 11, 1966, respectively (attached hereto as Exhibits A and B). Satisfying the foregoing obligations is not necessarily to be interpreted as amending, changing, or satisfying in any manner the requirements of Article 28 of the contract of January 17, 1969, between the United States and the Salt River Project Agricultural Improvement and Power District, Contract No. 14-06-400-5033; Article 5 of the contract of April 11, 1968, between the United States and Utah Construction and Mining Company, Contract No. 14-06-400-4831; Article 5 of the contract of April 11, 1968, between the United States and Public Service Company of New Mexico, Contract No. 14-06-400-4821. Any revision, modification or termination of this contract and any default by a party hereunder or cancellation or termination of the contract by any party hereto shall not in any manner revive, recreate, or reinstate any of the terms, covenants and conditions in the aforementioned letters nor the obligations of any non-Federal Party with regard thereto satisfied by this Article 12, except by written consent of all the parties to this contract.

ARTICLE 13

TRANSACTIONS OUTSIDE THIS CONTRACT

13.1 Nothing contained in this contract shall preclude any party from entering into transactions with any entity for the sale or purchase of energy upon terms and conditions other than those set forth in Articles 6 and 7 hereof.

ARTICLE 14

NO AMENDMENT OF OTHER CONTRACTS

14.1 Except with respect to the exchange of correspondence described in Article 12.1, nothing contained in this contract shall be construed to alter, modify or in any manner affect the rights or obligations of any party hereto to any other party hereto or to third parties under any other contract.

ARTICLE 15

COORDINATION COMMITTEE

15.1 A Coordination Committee shall be established consisting of one representative from each of the parties to this contract. Each representative shall have one alternate. The Coordination Committee shall be responsible for administering this contract and establishing procedures to implement this contract. All actions of the Coordination Committee shall be by unanimous action and shall be reduced to writing. The Coordination Committee shall appoint such subcommittees and establish such work groups as it considers necessary.

15.2 In addition to its other duties as set forth in this contract, the Coordination Committee shall establish standard practices and procedures for:

15.2.1 Establishment of points of interconnection.

15.2.2 Scheduling of deliveries.

15.2.3 Billing procedures.

15.2.4 Calculation and accounting for losses.

ARTICLE 16

APPROVAL OF REGULATORY AGENCIES

16.1 The parties hereto who may be required to do so agree that following the execution of this contract they will promptly prepare and file with all regulatory agencies having jurisdiction in the premises an application for any requisite authority to perform the obligations herein provided for. This contract shall be ineffective as to any such non-Federal Party who fails to obtain the necessary approval or acceptance by regulatory agencies having jurisdiction with respect thereto.

ARTICLE 17

GENERAL POWER CONTRACT PROVISIONS

17.1 The General Power Contract Provisions effective April 27, 1961, with revised page 2 dated August 7, 1968, and revised page 3 dated January 2, 1969, attached hereto are hereby made a part of this contract; provided, however, that Provisions B, C, D, F, G, H, I, J, K, L, M, N, Q, Y, Z and AA through FF, shall not apply to this contract, and provided that, as to Provision P, since Title 42 U.S.C. 2000 e-2(i) provides for the giving of preference to Indians in employment on or near an Indian Reservation, the obligations of the non-Federal Parties under Provision P' shall be subject to any obligation undertaken by a non-Federal Party to give preference to Indians for employment for work on or near an Indian Reservation.

IN WITNESS WHEREOF, the parties hereto have caused this Power Coordination Contract to be executed as of the day and year first above written.

THE UNITED STATES OF AMERICA

By /s/ Walter J. Hickel
Secretary of the Interior

ARIZONA PUBLIC SERVICE COMPANY

ATTEST:

/s/ Wm. T. Quinsler
Secretary
(SEAL)

By /s/ M. C. Titus
Vice President

SAN DIEGO GAS & ELECTRIC COMPANY

ATTEST:

/s/ C. Hayden Ames
Assistant Secretary
(SEAL)

By /s/ W. A. Zitlau
Executive Vice President

SOUTHERN CALIFORNIA EDISON COMPANY

ATTEST:

/s/ J. C. Bobek
Assistant Secretary
(SEAL)

By /s/ J. K. Horton
Chairman of the Board

APPENDIX I-10

State of Utah Executive Order Creating the Kaiparowits Planning and Development Advisory Council

APPENDIX I-10

STATE OF UTAH

EXECUTIVE DEPARTMENT

1896

EXECUTIVE ORDER

WHEREAS, the introduction of new energy resource activities into Garfield and Kane Counties will have an impact of considerable magnitude on the existing pattern of development; and

WHEREAS, in anticipation of this impact, there exists a need for a coordination process to facilitate planning and decision-making between federal, state, and local governments; and the private sector concerning energy resource developments; and

WHEREAS, the local elected officials of Kane and Garfield Counties recognize the importance of providing a means by which all proposed activities having a direct influence on the future development of the area should be reviewed and taken into consideration:

NOW, THEREFORE, I, Calvin L. Rampton, Governor of the State of Utah, by virtue of the authority vested in me by the Constitution and Laws of the State of Utah, do hereby order as follows:

There is hereby created a Kaiparowits Planning and Development Advisory Council to guide and coordinate activities related to energy development in Kane and Garfield Counties.

I. The purposes of the Council are:

A. Function as a local clearinghouse for energy planning and development activities underway or proposed for Kane and Garfield Counties.

B. Develop and provide state and county local input to the Environmental Impact Statement being developed by the Federal Department of Interior - Bureau of Land Management.

C. Through participating governmental and private agencies, identify and/or secure funding and other resources to assist in planning and development efforts related to the Kaiparowits or other energy projects in the two counties, as needed.

D. Direct and/or carry out specific energy related planning or development activities, as requested by the counties or other participating governmental units or agencies.

E. Function as the liaison and communication body between the private development corporations, community and federal, state, and local agencies directly related to the Kaiparowits and other energy projects in Kane and Garfield Counties.

F. Implement a process whereby community input may be received and reviewed by the Council and a continuing public education program is carried out.

G. Coordinate Kaiparowits and other energy construction and development planning with county planning and municipal development so as to attempt to prevent an influx of workers and related population to areas where there are not adequate and attractive housing and related facilities.

II. To fulfill the purposes of this Order, any agency of local, state, or federal government, any state or private university, or private developer initiating studies, plans, or specific development proposals, affecting the utilization of energy resources shall first submit such studies, plans, or development proposals to the Council for their review and recommendations to insure optimum coordination of energy resource development.

The Council shall consist of twenty-seven (27) representatives as follows:

Merrill R. MacDonald, Kane County Commissioner
James M. Yardley, Garfield County Commissioner
Dixie Leavitt, Utah State Senator
S. Garth Jones, Utah State Representative
Fred B. Harris, Beaver County Commissioner
  Representing Five-County Association
  of Governments

William G. Bruhn, Executive Director
  Department of Community Affairs
Burton L. Carlson, State Planning Coordinator
Clem Church, State Road Commission
Gordon M. Harmston, Executive Director
  Department of Natural Resources
Herbert J. Allen, Manager, Department
  of Employment Security, Panguitch
Milton L. Weilenmann, Executive Director
  Department of Development Services
Paul S. Rose, Executive Director
  Department of Social Services
Blaine Kay, Director, Department of Highways
Morgan S. Jensen, District Manager
  Bureau of Land Management, Kanab
Earle B. Curran, Superintendent, Cedar
  Breaks National Monument
  National Park Service
Walter W. Pierson, District Forest Ranger
  Dixie National Forest, Forest Service

Dale Marsh, Garfield County Commissioner
Sterling Griffiths, Kane County Commissioner
Vernon Barney, Garfield County School District
Doyle Swallow, Kane County School District
Dr. Wallace G. Lee, Mayor of Panguitch
Claude M. Glazier, Mayor of Kanab
George Rampton, Dixie College
Dr. McRay Cloward, Southern Utah State College
James Carrico, Citizen's Advisory Committee
    Kane County
Robert S. Currie, Project Manager
    Southern California Edison Company
Elton H. Buell, Vice President,
    Resource Company, Arizona

The first five members above designated shall constitute an Executive Committee with the authority to act between meetings of the full Council. The Executive Committee shall designate from its members an individual who shall serve as chairman of both the Council and the Executive Committee.

The initial appointees to the Council, or their successors, shall serve until such time as the Council is dissolved by the Governor.

Staff support to serve the Council shall be provided by state government agencies and the Five County Association of Governments as required.

IN WITNESS WHEREOF, I have set my hand and caused to be affixed the Great Seal of the State of Utah. Done at the State Capitol in Salt Lake City, Utah, this 7th day of August, 1974.

By the Governor

Clyde L. Miller
Secretary of State
By Eula C. McCoy
Assistant Deputy

Calvin L. Rampton
Governor

APPENDIX I-11

Kaiparowits New Town Study,
Call Engineering, Inc.

APPENDIX I-11

KAIPAROWITS NEW TOWN

Environmental Impact Data

December 2, 1974

Prepared by

Call Engineering, Inc.
2211 South 300 West Street
Salt Lake City, Utah
84115

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CONSULTING
ENGINEERS
AND
PLANNERS

December 2, 1974

Mr. Frank Snell
Department of the Interior
Bureau of Land Management
Salt Lake City, Utah

Dear Mr. Snell:

Our firm has been retained to perform an Economic and Marketing Feasibility Study for the proposed Kaiparowits New Town. This study is being done under the auspices of the Kaiparowits Planning and Development Advisory Council.

As a part of this study we have developed the enclosed plan and engineering data for one potential town configuration on the East Clark Bench site. This plan was prepared as a working tool to facilitate the feasibility study.

We anticipate that the developer selected to construct and administer the new town will modify the plan to suit his development plans however, the general data on space and material requirements and other similar items may be considered as constant.

In the same manner, if one of the alternate sites is selected for the town, those same items will remain constant although the physical configuration of the plan will be changed to adapt to the terrain.

The economic and marketing portion of the study is still in data gathering stage and the analysis and evaluation work has not yet progressed to the point that meaningful conclusions can be drawn.

We have compiled the attached chart showing driving times for workers to the mine and plant sites from various locations. Due to the relatively long driving times we are investigating several potential town sites in addition to East Clark Bench.

The alternate town sites which we are investigating are Butler Valley, Long Flat, Fourmile Bench and Nipple Bench. Both the Fourmile and Nipple Bench sites are adjacent to the proposed power plant sites. Descriptions of the general areas under consideration are enclosed.

The economic and marketing study will provide data on the population anticipated for the new town and the housing mix and other service requirements. As this information has not yet been developed, we have used the projections contained in the Kaiparowits New Town Study II prepared by John Willie.

Time did not permit the development of the three year and six year development phasing schedule. We are currently working on this item and will submit it to you as soon as possible.

Our staff will be available to meet with you to review and discuss this material at your convenience. Please contact the undersigned to arrange for meetings or if you have any questions.

Very truly yours,

CALL ENGINEERING, INC.

John F. Nelson

John F. Nelson, P.E.

JFN/mw

cc: Kane County Commissioners
Kaiparowits Planning and Development Advisory Council Executive Committee
Southern California Edison Co.
Resources Company
Kaiser Industries

KAIPAROWITS NEW TOWN

Proposed Development Procedure

The Kaiparowits New Town will be developed by a major private developer to be selected by the cooperative efforts of the Utility Companies, Kane County and the Kaiparowits Planning and Development Advisory Council.

The developer will construct and manage the new town in a manner similar to an ordinary land development, or subdivision, project in that the normal planning, zoning and building requirements will be regulated by Kane County. The County will review its subdivision and zoning regulations, County master plan and building codes prior to the start of the development process. These regulations and codes will be revised as necessary to insure that the new town will be constructed to the highest standards consistent with current economic building practices.

Kane County will provide the planning and engineering staff to regulate and monitor the developer. This staff will either be employed directly by the County or will be retained on a consulting basis. The staff will be paid for out of various fee and permit revenues and/or by general taxes in the later years of the development. It may be necessary for the developer to advance some of the initial permit fees to finance the early staff requirements.

The County will obtain Federal, State or private grants to help finance the review and updating of the codes and regulations.

All costs for planning, engineering and construction of the new town will be paid by the developer. These costs will be recovered in the sale or rental of residential units and commercial/ industrial sites or buildings.

Close liaison and, possibly, contractural arrangements will be established and maintained between the developer, the Utility Companies, Kane County and the Kaiparowits Planning and Development Advisory Council to insure that facilities will be provided in competitive price ranges and that all facilities, including social and recreational, will be provided in a timely manner.

The developer may elect, with the cooperation of Kane County, to form a Special Service District to assist in the funding, construction, operation and maintenance of some or all of the public facilities.

The developer will be required to operate under all applicable Federal and State laws and regulations pertaining to employment practices and construction safety.

Federal land required for the new town will be acquired by the developer through the State of Utah land selection procedure. If satisfactory arrangements can be made, the land could be transferred directly to the developer from the United States.

Land for public uses will be acquired by Kane County or, if applicable, the Special Services District. This transfer will be either direct or through the State of Utah.

Those public services not provided by a Special Services District will be provided by the appropriate County or State agency. Schools will be provided by the Kane County School District. The developer will provide either temporary or permanent school facilities, as appropriate, for the initial phases of the new town.

The County and the School District may seek Federal, State or private grants to assist in the financing of the initial staff until such time that tax and other revenues are sufficient to pay for them.

It is the expressed intent of all parties and agencies involved in the development of the new town that any facility or staff requirement will not become a burden on the general residents of Kane County or the State of Utah.

EAST CLARK BENCH TOWN SITE

Township 42 South, Range 2 East, Salt Lake Meridian
- Section 32: South 1/2
- Section 33: Southwest 1/4

Township 43 South, Range 2 East, Salt Lake Meridian
- Section 3: South 1/2, Northeast 1/4
- Section 4: All
- Section 5: All
- Section 8: North 1/2
- Section 9: North 1/2
- Section 10: All
- Section 11: All
- Section 14: North 1/2

Containing 4,480 Acres, more or less.

Note: The above description contains the proposed town site. The description includes some private ownership and some Utah State ownership. It also contains land outside the limits of the plan as drawn. The precise description of the land required will be prepared at the time final development plans are completed.

FOURMILE BENCH TOWN SITE

Township 39 South, Range 2 East, Salt Lake Meridian
- Section 34: All
- Section 35: All
- Section 36: South 1/2

Township 40 South, Range 2 East, Salt Lake Meridian
- Section 1: All
- Section 2: All
- Section 3: All
- Section 11: Northeast 1/4
- Section 12: All

Township 40 South, Range 3 East, Salt Lake Meridian
- Section 6: West 1/2
- Section 7: All

Containing 5,280 Acres, more or less.

Note: The above description appears to contain sufficient area of suitable terrain for the proposed town site. The description may include some land under Utah State ownership.

LONG FLAT TOWN SITE

Township 39 South, Range 1 East, Salt Lake Meridian

Section 1: All
Section 2: All
Section 11: All
Section 12: All
Section 13: East 1/2

Township 39 South, Range 2 East, Salt Lake Meridian

Section 6: All
Section 7: All
Section 8: All
Section 17: North 1/2
Section 18: North 1/2

Containing 5,440 Acres, more or less.

Note: The above description appears to contain sufficient area of suitable terrain for the proposed town site. The description may contain some land under Utah State ownership.

BUTLER VALLEY TOWN SITE

Township 38 South, Range 1 West, Salt Lake Meridian

- Section 25: All
- Section 26: All
- Section 27: East 1/2
- Section 34: East 1/2
- Section 35: All
- Section 36: All

Township 39 South, Range 1 West, Salt Lake Meridian

- Section 1: All
- Section 2: East 1/2

Township 38 South, Range 1 East, Salt Lake Meridian

- Section 31: All

Township 39 South, Range 1 East, Salt Lake Meridian

- Section 5: West 1/2
- Section 6: All

Containing 4,800 Acres, more or less.

Note: The above description appears to contain sufficient area of suitable terrain for the proposed town site. The description may include some land under Utah State ownership.

MASTER PLAN LAND USE COMMENTS

I will try and give you a brief rundown of my thoughts as they were incorporated in the attached preliminary master plan (bear in mind that the numbers regarding dwelling units, population, school enrollment, etc. were all based on Willie's second report). The easiest way to do this is to follow the categories as they are listed on the attached land use allocation.

GAC - Garden Apartments and/or Condominiums:

1. Located in close proximity to arterial and/or collector streets and commuter stations.

2. Adjacent to compatible uses.

3. At density proposed, adequate area allowed for open space and recreation complex (i.e., bachelor housing situation--pool area, recreation building and barbecue area).

TDF - Townhouses and/or 2 or 4 Plexes:

1. Located in close proximity to arterial and/or collector streets and commuter stations.

2. Adjacent to compatible uses.

3. Centrally located recreation center.

4. Looping local street for adequate circulation--groups of townhouses/plexes would be served by private drives.

5. Density proposed should allow for 30%-40% open space/landscaping/recreation area.

6. Can be designed to as not to look too dissimilar from the cluster subdivision area.

SFC - Single-Family Cluster/Patio Homes:

1. Closer orientation to elementary/junior high school sites.

2. Thoughts on geometry of lots--zero lot line one side, 10 feet on the other; lot size 50' x 80' or 50' x 90'; and private patio and garden area in each backyard, balance into common area.

3. Possibility of reverse frontage dwelling units (i.e., dwelling front to common area and pedestrian/bike ways--garage and patio/garden towards access street)

4. Common area beyond pedestrian/bike paths available for drainage swales.

5. Dwelling units within one-half mile radius of commuter stations and elementary school sites.

6. Local street circulation in most easterly complex allows secondary access to church sites and access to school site.

7. Intended that there be open space strips between lots and adjacent arterial or collector streets.

SFD - Single-Family Detached Homes:

1. Intended to be located so that there is a variety in neighborhood dwelling mix, while at the same time being composed of enough units to retain their initial detached unit identity.

2. Project density would allow some sort of small recreation complex in each neighborhood.

3. Proposed density (3.0 d.u./gr. ac.) should yield lots ±9,400 square fee (± 75' x 125') and allow approximately 25% for streets and 10% open space beyond the area required for lots.

4. Most areas with one-half mile radius of commuter stations and elementary school sites.

5. Provision for "prestige" lots (close to one-half acre) in area of proposed golf course. Basic lot size would be 17,000 square feet (90' x 190') allowing 22% of gross area for streets (12%) and open space (10%)

6. Provision for equestrian and/or "4-H" project lots in most northerly part of community (prevailing winds per Willie report are from southeast and southwest so this appears to be best location for these if the demand is there). Lots would average ±38,000 square feet (110' x350') allowing 12% of gross area for streets.

MHC - Mobilehome (Subdivision) Later Convertible to Single-Family Detached:

1. Intended to result in a complex that could later on be an integral part of adjacent SFD neighborhoods or have an SFD identity of its own.

2. Density being a little higher (3.5 d.u./gr. ac.), these areas may be more adaptable to lower priced housing at

their time of conversion to detached units (initial site development should be predicated on this potential conversion). Interim period of inflation will probably also promote housing with less floor space than the SFD areas.

3. Density proposed should yield lots in the 8,000 square foot range (±70' x 115'), allowing 35% of the gross area for streets (25%) and open area (10%).

4. Areas located within one-half mile radius of commuter stations and elementary schools.

5. RRC located within these neighborhood units should probably be developed in advance of those with the SFD areas because owner occupation with site (lot) development will probably involve less time.

MHP - Mobilehome Park Permanent:

1. Neighborhood circulation by looped local streets. Balance of access by streets/drives of lesser width compatible with the density of mobilehome parks.

2. RRC's in these areas should be larger in line with increased density.

3. Intended to have greenbelt buffer between units and adjacent arterial or collector streets. .

4. Basic lot (space) geometry, allowing 40% of the gross area for streets/drive (25%) and open spaces (20%) could be approximately 46' x 86' (±4,000 square feet).

5. Most areas within one-half mile radius of elementary schools and commuter stations.

C-1 - Neighborhood Shopping:

1. Located within approximately one-mile radius of residential areas.

2. Proximity to arterial/collector streets and commuter stations is reasonable.

3. Surrounding greenbelts provide buffer to adjacent uses and would allow pedestrian/bike route access.

4. Area proposed should provide adequate space for the normal convenience shopping needs plus parking with suf-

ficient areas for landscaping so as to prevent the "sea of asphalt" look usually associated with neighborhood centers.

C-1-A - Medical/Professional:

1. Centrally located.

2. Convenient location in relation to hospital and civic center complex.

3 Close proximity to initial higher density development.

4. Same comment as under Item 4, C-1.

C-2 - Community Shopping Center:

1. Centrally located with good arterial access.

2. Compatible use to the west; north and east adjacent areas either in open space or buffered by greenbelt strip for pedestrian/bike access.

3. Same comment as under Item 4, C-1.

C-H - Highway Services:

1. Buffer by NOSB along state highway and landscape strips along entrance arterials should help prevent appearance of highway "strip" development.

2. Locations at easterly/westerly extremities of community intended to reduce (as much as possible) highway traffic circulation through core of community.

3. Same comment as under Item 4, C-1.

L-1 - Light Industry:

1. Area has good access to state highway and "proposed" access to power plant and mine sites.

2. Closest relationship to Lake Powell and possible recreational industry tie-in.

3. Separation from adjacent land uses by extensive NOSB (these may or may not be landscaped and/or bermed for additional buffering, or left in natural state).

4. Circulation by industrial type street (suggest 64 foot R.O.W.) located to allow development of 1 acre sites (±110' x 400') or multiples thereof.

5. Zoning/health department industrial development standards would control smoke, noxious odors, etc.; however, if normal wind direction (from southeast and southwest) is as per Willie's report, majority of community would not be in line of flow if there is a lapse in meeting standards.

CC - Civic Center:

1. Central location and bears desirable relationship to medical/professional complex, hospital and community recreation and cultural center.

2. Properly developed, can provide a positive visual impact (together with CRC) between the community and adjacent state highway.

3. Convenient access furnished by adjacent arterial streets and CBS.

4. Center assumed to accommodate facilities for: police department, county/state sub-offices, special district--city offices, etc.

H - Hospital:

1. Central location, relationship to medical/professional area.

2. Convenient access by arterial streets to community and state highway and CBS.

3. Buffered from adjacent uses by NOSB.

FS - Fire Station:

1. Each site located centrally within adjacent residential areas.

2. Close proximity to elementary/junior high school sites.

3. Direct access to collector streets.

MY - Maintenance Yard:

1. "Trade off" relationship to both facilities within community and "proposed" plant/mine access road.

2. Located within area of compatible land use.

R - Church:

1. Access through arterial, collector and local streets and greenbelts.
2. Greenbelt strips and/or NOSB buffer adjacent residential areas and vice versa.
3. Additional site possible within parochial school site.

ES - Elementary School:

1. Basically located to be within one-half mile radius of residential units and adjacent to, or in close proximity of, pedestrian/bike pathways.
2. All sites in companion with a neighborhood park site.
3. Convenient access on collector streets, but intentionally not located adjacent to higher speed/traffic volume arterial streets.
4. Student population projections based on age group forecast contained in Willie report, page 76. Arrived at by the following method:

1986: Population in age group 5 - 9 = 1,453
45% of population in age group 10 - 14 = 687

Estimated population age group 5 - 11-1/2 (normal age range K-6 students) = 2,140

$\frac{\text{2,140 ages 5 - 11-1/2}}{\text{15,234 total population}}$ = 14% of total population in elementary grades K-6

	Residential Area Easterly of Civic Center	Residential Area Westerly of Civic Center	Totals
Total D.U.	2,432	2,707	5,139
% of Total	47%	53%	100%
Estimated Share of Total Population (15,234)	7,160	8,074	15,234
% in Elementary Grades K-6	14%	14%	
Elementary Grade Students	1,002	1,130	2,132
Students per Elementary School	501 (10 ac. site) 501 (12 ac. site)	500 (10 ac. site) 630 (12 ac. site)	

JH - Junior High School:

1. Sites shown (15 acres each) are smaller than normally recommended (25 acres) for efficient school population/ plant operation balance. Age group projections indicate one (1) site could handle population of junior high age group. However, because of linear distance of community and effect of two (2) separate neighborhood core areas, I have shown the two (2) sites.

   Note: There is always the potential of additional students coming from Church Wells/Paradise Oasis area and the government small tract area in Section 14.

2. Sites have convenient access on collector streets, are tied to NOSB and/or GB and basically, centrally located within a one-mile radius of the residential areas.

SH - Senior High School:

1. Convenient access to both arterial and local streets plus NOSB and GB area.

2. Appropriate relationship to central portion of community and also the proposed community recreation and cultural center.

3. Primary athletic field (football-track) should be oriented adjacent to the NOSB. This relationship would allow a parking area within the CRC to serve a dual function for athletic events (i.e., park at CRC and walk across NOSB to field).

PS - Parochial School:

1. Location has advantage of adjacent park site.

2. Per Item 3 under R (Church), facility provides an additional site for possible church.

WTP - Water Treatment Plant and/or Storage Facility:

See separate narrative regarding master water system.

STP - Sewer Treatment Plant:

1. Site "A" less obtrusive from visual impact if gravity system can be designed to this location. Access could be from mine/plant access road. Possible readjustment of golf course location may make it feasible to pump treated effluent for golf course irrigation. Most centrally located with respect to running trunk lines to serve both areas of the community.

2. Site "B" more practical with regard to possible future service to government small tract area. Gravity system may work best with this site. Access from mine/plant access road.

3. Both sites would not appear to present odor problems to the community when prevailing winds are from the southwest. Site "A" would be least offensive if wind direction is also from the southeast.

SL - Sanitary Landfill:

1. Removed from active stream beds (+1-1/2 miles from Coyote Creek; 3-1/2 miles from Wahweap Creek).

2. Access, via Highway 89, would not involve major drainage crossings.

3. Could serve Church Wells/Paradise Oasis area.

4. Water supply for dust control/compaction would have to be developed.

5. Better topographic information may indicate an alternate site within the area of the north halfs of Sections 31 and 32 would be better.

6. Based on prevailing winds from southwest and southeast, should not be offensive.

A - Airport:

Too preliminary to comment on at this time.

CBS - Commuter Bus Station and Intersection Landscaping:

1. Locations within one-half mile radius of most all residential areas.

2. Provide dual purpose function: (a) central pickup and dispersal area for mine/plant personnel; (b) station location design and landscape distribution can be done so as to prevent sight distance encroachments at major street intersections.

3. Greenbelt ties to such stations could provide for pedestrian/bike routes between the stations and adjacent residential areas.

CRC - Community Recreation and Cultural Center:

1. Approximately half (15 acres) of the site should be developed as a community park area. Balance useable for multi-cultural center*, library, theater/music playhouse, parking, etc.

   *Location of several cultural centers at one site (as opposed to being fragmented within various neighborhoods) would appear to lead to a closer integration of various ethnic groups and development of a community relationship and spirit).

2. Centrally located, bounded by compatible uses.

3. Good access from arterial street.

NP - Neighborhood Parks:

1. Placed adjacent to elementary school sites to allow dual use. Most are also adjacent to NOSB or primary GB areas to allow a pedestrian/bike path tie between residential areas and the parks.

RRC - Residential Recreation Center:

1. Centrally located within most of the residential neighborhoods and townhouse complexes.

2. Anticipated size 1/2 to 1 acre.

3. Uses could run from swimming pool/recreation building complex to a relatively unimproved facility such as a "tot lot" or natural area playfield.

4. Maintenance could be handled by an overall parks/recreation type district or by neighborhood or homeowners association method.

GC - Golf Course:

1. Initial location occupies terrain which would provide variety in placement of greens and tees and allows primary north-south orientation of each hole of the course (accurate topography may indicate that the course could be condensed in the north-south direction, expanded easterly and thereby reduce frontage along the adjacent arterial street).

2. Initial layout provides a course of Par 71, approximately 6,500 yards in length.

3. With more detailed study, it would appear possible to shift such a course to a location which would be feasible from the standpoint of utilizing effluent from the sewage treatment plant for irrigation purposes.

GB - Greenbelts and/or Bike/Pedestrian Ways:

1. Intended to provide buffers and/or links between various land uses and to the NOSB areas.

2. Minimum care landscaping should be provided wherever practical, particularly along the entrance streets to the community.

3. Anticipated that widths of these strips would vary from 10 feet to 30 feet.

4. Where strips connect to streets at locations other than at intersections, it is recommended that crossing be limited to the nearest street intersection.

NOSB - Natural Open Space Buffers:

1. Occur primarily along major drainage courses, adjacent to State Highway 89 and along the existing 230 KV transmission line.

2. These buffers vary from 100 feet to 300 feet in width and for the most part, are intended to be left in their natural state. An exception to "natural state" would be the recommendation that tree planting be done within that strip adjacent to the state highway for purposes of acting as a windbreak and sound and sight buffer.

3. In relation to Item 2 above, the subject NOSB may be an appropriate area to commence a "tree farm/landscape shrubbery" facility during the very initial stages of development of the community.

4. Included within this acreage is a 20 acre cemetery site northwest of the community proper.

PROPOSED NEW COMMUNITY - EAST CLARK BENCH SITE

PRELIMINARY MASTER PLAN - LAND USE ALLOCATION

				% of Gross Residential Area	
Land Use	Gross Acres	Dwelling Units	Density (d.u./gr. ac.)	Acres	Units
Residential					
GAC - Garden Apts. and/or Condominiums	27.0	256	8.0	2.4	5.0
TOF - Townhouses and/or 2 or 4 Plexes	70.0	504	6.0	6.3	9.8
SFC - Single-Family Cluster/ Patio Homes	174.0	748	3.6	15.5	14.5
SFD - Single-Family Detached Homes	402.0	1,230	2.6	35.9	23.9
	(646.0)	(2251)	(2.9)	(57.7)	(43.8)
MHC - Mobilehome Converted to SFD	244.0	1,021	3.5	21.8	19.9
MHP - Mobilehome Park - Permanent	203.0	1,380	5.7	18.1	26.9
TOTALS	1,120.0	5,139	3.8 Ave.	100.0	100.0

	Gross Acres	Number of Sites
Commercial		
C-1 - Neighborhood Shopping	9.0	2
C-1-A - Medical-Professional	5.0	1
C-2 - Community Shopping	15.0	1
CC - Highway Services	16.0	2
TOTALS	45.0	6

(Note: Figures on pages 170, 171, 172 modified from original report.)

Land Use	Gross Acres	Number of Sites
Industrial		
LI - Light Industry	135.0	2
TOTALS	135.0	2
Public and Quasi-Public Services		
CC - Civic Center	20.0	1
H - Hospital	9.0	1
FS - Fire Station	2.0	2
MY - Maintenance Yard	3.0	1
R - Church	8.0	5
SUB-TOTAL	50.0	(10)
ES - Elementary School	38.0	4
JH - Jr. High School	26.0	2
SH - Sr. High School	34.0	1
PS - Parochial School	6.0	1
SUB-TOTAL	104.0	(8)
WTR/STP - Water and Sewage Treatment	43.0	1 Each
SLF - Sanitary Landfill	172.0	1
CBS - Commuter Bus Station and Intersection Landscaping	10.0	8
SUB-TOTAL	225.0	(12)
TOTALS - PUBLIC AND QUASI-PUBLIC SERVICE	380.0	28
Recreation and Open Space		
CRC - Community Recreation and Cultural Center	26.0	1

Land Use	Gross Acres	Number of Sites
NP - Neighborhood Parks	19.0	4
RRC - Residential Recreation Center	9.0	16
GC - Golf Course	134.0	1
G/B - Greenbelts and/or Bike/Pedestrian Ways	9.0	-
NOSB - Natural Open Space Buffers (inc. 20 ac. cemetery)	273.0	-
TOTALS	470.0	22
Streets		
Arterials and Collectors	90.0	
TOTALS	90.0	

TOTAL - ALL MAJOR CATEGORIES = 2,240 ACRES

SUMMARY OF LAND USE ALLOCATION

Land Use - Major Category	Gross Acres Per Category	Gross Acreage % of Overall Total
RESIDENTIAL		
Multi-Family and/or Attached Dwelling Units (GAC and TDF Areas)	97.0	(4.0)
Single-Family Detached Dwelling Units (SFC, SFD, and MHC Areas)	820.0	(32.0)
Permanent Mobilehome Dwelling Units	203.0	(8.0)
	1,120.0	44.0
COMMERCIAL	45.0	2.0
INDUSTRIAL	135.0	5.4
PUBLIC AND QUASI-PUBLIC SERVICES	380.0	27.4
RECREATION AND OPEN SPACE	470.0	18.0
STREETS (Arterials and Collectors Only)	90.0	3.2
TOTALS	2,240.0	100.0

GENERAL COMMENTS

A. Dust Control

It will be necessary during construction operations to provide for dust control; the proposed method of mitigating this nuisance will consist of applying either water or a dust palliative. The dust control operations should be performed by a Contractor at the time, location and in the amount ordered by the Engineer of work. The control of this item by the Engineer of work will not prevent the Contractor from applying water or dust palliative for his convenience if he desires.

B. Erosion Control

The proposed New Town construction will have an impact on the existing undisturbed soils. Removal of the native vegetative cover from the soils will greatly increase the potential for accelerated erosion.

The two major factors contributing to accelerated erosion, during the construction period, will be storm water runoff and wind.

The most significant post construction impacts on the soils are related to the increase in total impervious surface and concentration of runoff.

Several measures can be taken to mitigate some of the anticipated impact of the development on soils. They include:

1. Applying water or a substitute palliative to the soils during dry periods of construction operations.
2. Development and timely implementation of revegetation plans for all cleared or distrubed areas.
3. Provide temporary drainage devices, sand bags, etc. during periods of inclement weather.
4. In the major watershed areas, plan the development preserving the natural water courses with a minimum amount of disturbance. In those areas requiring construction, develop drainage devices and protective works to minimize erosion.
5. Conduct detailed soils analysis of areas proposed for intensive development prior to construction.
6. Develop specific plans for control and handling of runoff, especially in areas where previous/impervious relationships are being modified.

7. Limit off-road vehicle activities within the development boundaries.

C. Impervious Surfaces

The following assumptions for the various proposed zoning classifications were made to enable the preliminary calculations of impervious surfaces:

1. LI - Light Industry (Lot Size = ±1 Acre)

Building Size = ±17,500 S.F. = 2,625,000 S.F.
Driveways and Parking Area = ±17,500 S.F. = 2,625,000 S.F.

SUB-TOTAL 5,250,000 S.F.

2. CH - Highway Commercial (Lot Size = ±20,000 S.F.)

Building Size = ± 8,000 S.F. = 360,000 S.F.
Parking = ± 8,000 S.F. = 360,000 S.F.

SUB-TOTAL 720,000 S.F.

3. C-1 - Neighborhood Shopping

Gross Acres - 12.0 - Assume 70%
Buildings and Parking = 8.4 Ac. x 43,560 S.F. = 365,904 S.F.

4. C-1-A - Medical Professional

Gross Acres - 6.0 - Assume 70%
Buildings and Parking = 4.2 Ac. x 43,560 S.F. = 182,952 S.F.

5. C-2 - Community Shopping

Gross Acres - 20.0 - Assume 70%
Buildings and Parking = 14 Ac. x 43,560 S.F. = 609,840 S.F.

6. TDF - Townhouses and/or 2 or 4 Plexes
GAC - Garden Apartments and/or Condominiums

±30' x 60' Unit = 1,800 S.F. = 1,368,000 S.F.
Parking = 600 S.F. = 456,000 S.F.
Private Streets = 1,207,776 S.F.

SUB-TOTAL 3,031,776 S.F.

7. SFC - Single-Family Cluster/Patio Homes

Lot Size = ±4,500 S.F.		
House = ±2,000 S.F.	=	1,496,000 S.F.
Parking = ± 400 S.F.	=	299,200 S.F.
Patio = ± 200 S.F.	=	149,600 S.F.
SUB-TOTAL		1,944,800 S.F.

8. SFD - Single-Family Detached Homes

Lot Size = ±9,400 S.F.		
House = ±2,400 S.F.	=	2,952,000 S.F.
Parking = ± 400 S.F.	=	492,000 S.F.
Patio = ± 200 S.F.	=	246,000 S.F.
SUB-TOTAL		3,690,000 S.F.

9. MHC - Mobilehome (Subdivision) Convertible to SFD

Lot Size = ±8,000 S.F.		
Building Area = ±2,000 S.F.	=	2,042,000 S.F.
Parking = ± 400 S.F.	=	408,400 S.F.
Miscellaneous = ± 200 S.F.	=	204,200 S.F.
SUB-TOTAL		2,654,600 S.F.

10. MHP - Mobilehome Park - Permanent

Lot Size = ±4,000 S.F.		
24' x 60' Trailer = ±1,440 S.F.	=	1,347,840 S.F.
9' x 12' Porch = ± 108 S.F.	=	101,088 S.F.
2 Stalls - 20' x 10' = ± 400 S.F.	=	374,400 S.F.
SUB-TOTAL		1,823,328 S.F.

11. Public and Quasi-Public

Gross Acres - 662.0 Acres - Assume for Airport, Buildings and Parking = 120 Ac. x 43,560	=	5,227,200 S.F.

12. Streets

Approximate Total Impervious Area	=	43,079,728 S.F.
OR	=	±989 ACRES

D. Material Quantities

1. The approximate volumes of earth to be moved in the grading operations are as follows:

   a. Site Grading

      (1) LI Zone = 195,000 C.Y.
      (2) CH Zone = 58,500 C.Y.
      (3) C-1 Zone = 155,000 C.Y.
      (4) C-1-A Zone = 155,000 C.Y.
      (5) C-2 Zone = 400,000 C.Y.
      (6) TDF and GAC Zone = 85,000 C.Y.
      (7) SFC Zone = 265,000 C.Y.
      (8) SFD Zone = 430,000 C.Y.
      (9) MHC Zone = 530,000 C.Y.
      (10) MHP Zone = 146,000 C.Y.
      (11) Public and Quasi-Public = 1,150,000 C.Y.

      SUB-TOTAL 3,569,500 C.Y.

   b. Streets = 638,600 C.Y.

   c. Storm Drains = 40,000 C.Y.

   d. Water Facilities = 80,000 C.Y.

   e. Sewer Facilities = 180,000 C.Y.

      TOTAL EARTHWORK ±4,508,000 C.Y.

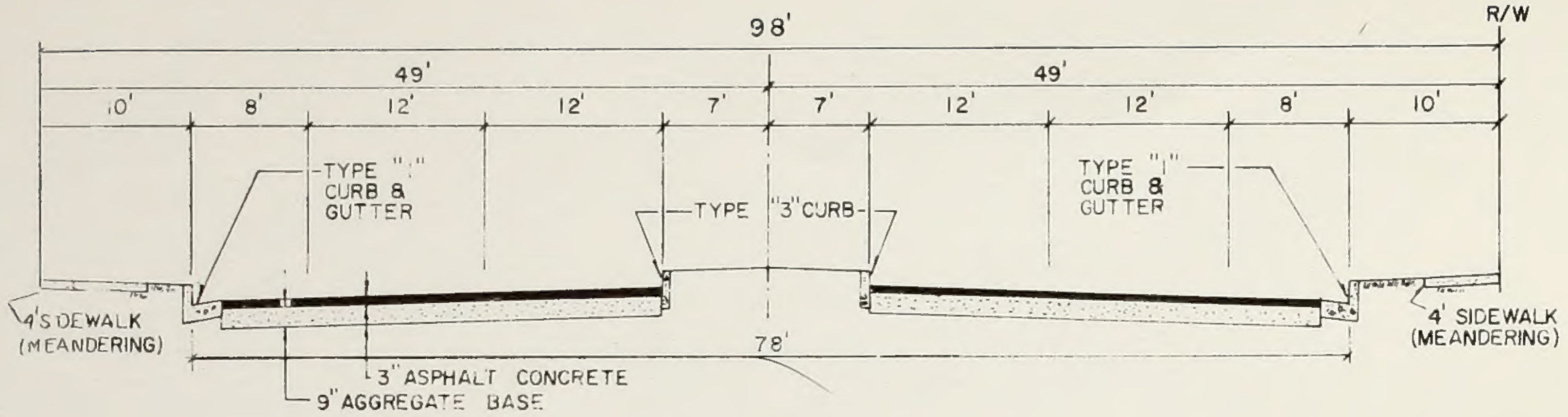
2. The approximate volumes of aggregates required to construct the various improvements are as follows:

   a. Aggregates to be utilized in driveways, parking lots and private streets for on-site improvements ±216,000 C.Y.

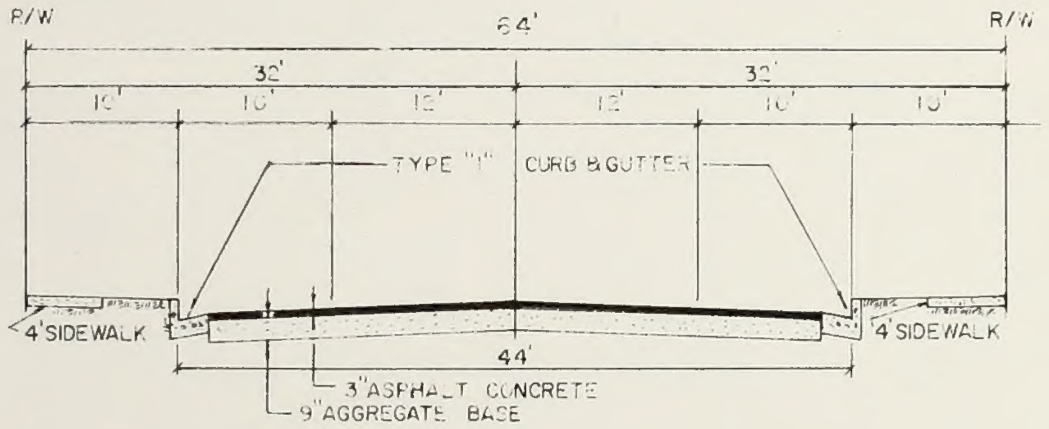
   b. Aggregates to be utilized in asphalt concrete, concrete sidewalks, concrete curb and gutter and base materials for streets ±255,000 C.Y.

   c. Airport improvement aggregates for asphalt concrete, base and sub-base material ±270,000 C.Y.

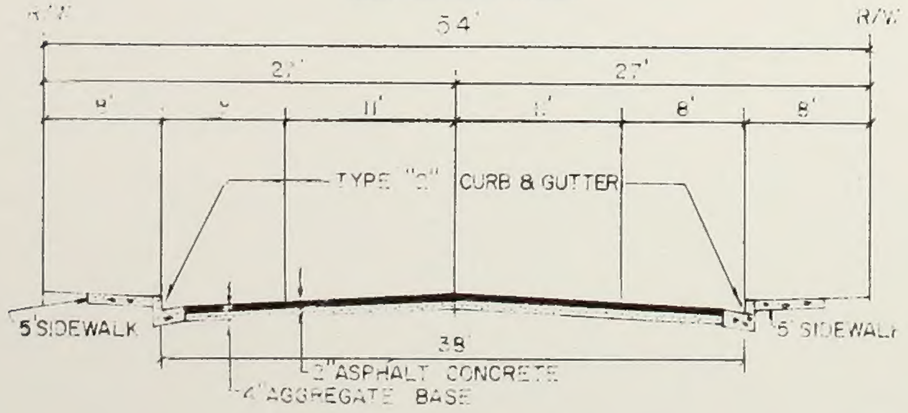
   d. Aggregates in connection with storm drain improvements ± 3,000 C.Y.



ARTERIAL

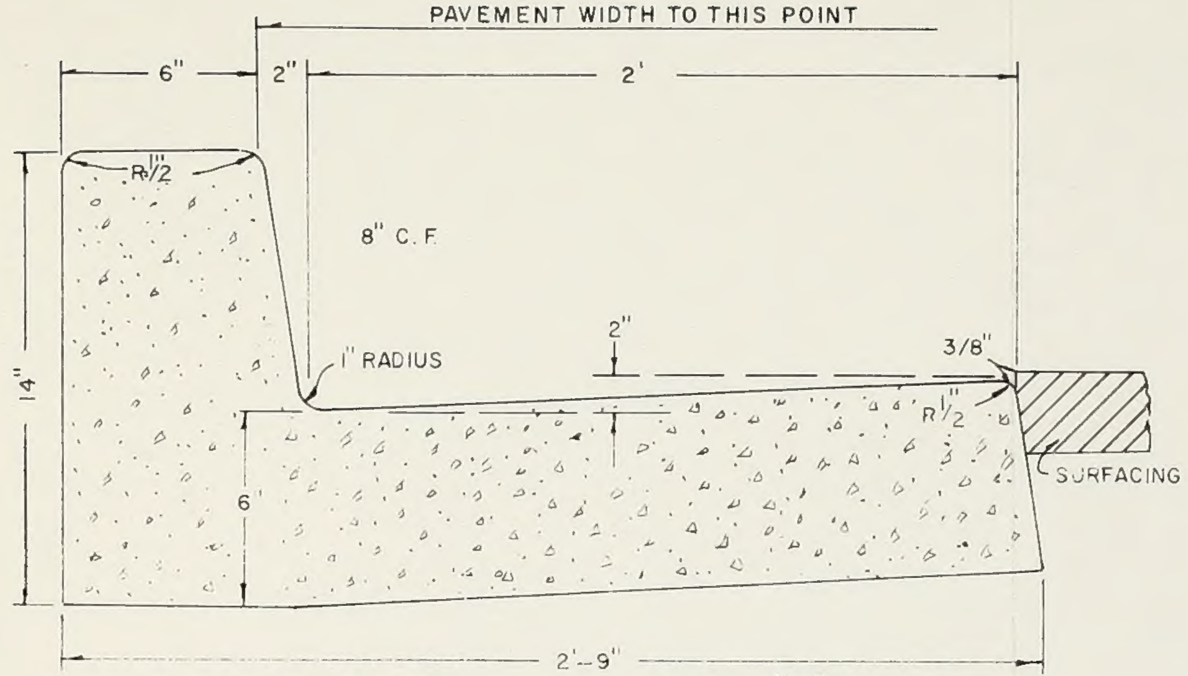


COLLECTOR
&
INDUSTRIAL



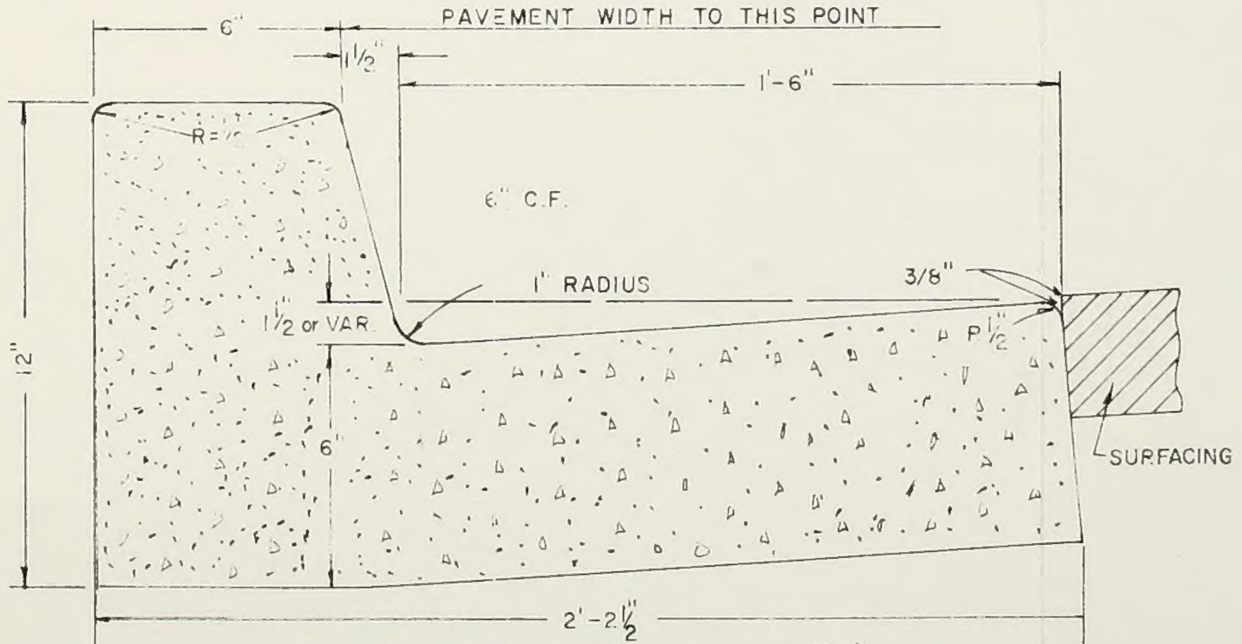
LOCAL STREET

NO SCALE



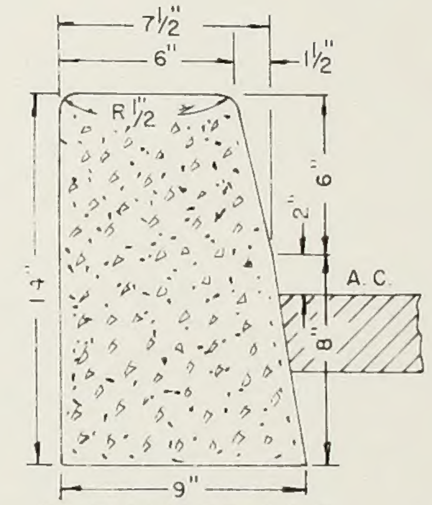
CONCRETE CURB TYPE "1"

NOTE
CONC. PER LIN. FT. = .0645 CU. YDS.
CU. YD. = 15.5 LIN. FT.



CONCRETE CURB TYPE "2"

NOTE:
CONC. PER LIN. FT. = 0.0505 CU. YDS.
1 CU. YD. = 19.8 LIN. FT.



C.Y. PER LIN. FT. = 0.027
L.F. PER C.Y. = 36.5

CONCRETE CURB TYPE "3"

NO SCALE

EXHIBIT "A"

e. Water facility aggregates	± 30,000 C.Y.
f. Sewer facility aggregates	± 45,000 C.Y.
AGGREGATE TOTAL	±819,000 C.Y.

3. Rip-Rap (Rock Slope Protection)

Rock slope protection will be needed in various areas of the project for erosion control. It is anticipated that the volume of rock rip-rap needed for the improvements can be obtained from the planned access roads to the mine and plant site. The estimated volume required is 1,000 cubic yards.

E. Streets

The proposed street improvements for the new community are depicted on the attached Exhibit "A". The proposed improvements are compatible to the zoning and subdivision ordinance of Kane County, Utah. Due to the preliminary nature of the circulation system and in absence of final traffic volume projections at this point in time, it is probable that changes to the proposed standards will occur. It is also possible that other means of transportation, along with bicycle and pedestrian traffic, will contribute to the final design components of the improvements prior to their construction.

Street Assumptions:

1. Earthwork quantities for roadways are based on all streets being in an excavated condition with the daylight point being at centerline of street finish grade. This does not mean that the ultimate street grade will always be in excavation, but does provide for a mean or balance point on which to base preliminary earthwork quantities and allows for drainage from the lots to enter the streets.
2. Clearing and grubbing quantities for the roadways are based on right-of-way widths plus 10 feet which should compensate for necessary slope rounding.
3. Since the "R-Value" of subgrade materials cannot be determined until the roadways are constructed, the structural roadway depths are preliminary.
4. The unit prices for the various items of work are based on construction contract costs experienced by M & Q Pacific, Engineers, and Call Engineering in numerous west coast and pacific southwest projects which are similar in nature. All estimates reflect present day costs.

F. Storm Water Control System

The major attention in the storm water control system preliminary design was to prvide protection for flash flood waters through developed areas, produced by the intense, short duration thunderstorms, frequent for this area.

Flood waters are carried through the new city by the existing drainage ways, thus preserving the natural streambed as vegetated open space or greenbelt, with culverts being provided along them as required for street or highway crossing.

This is not only responsive to flood and erosion protection, but to the recreational needs of people.

The method used for the computation of the peak rate of runoff in this drainage study was the "rational method".

Major drainage way crossings (box culverts) have been designed for a flood having an average frequency of occurrence of once in 100 years.

Rainfall intensity duration-frequency curves have been used for the Modena, Utah area extracted rom U. S. Department of Commerce Weather Bureau Technical Paper No. 25.

Because of the infrequent rainfall and low precipitation in the Kaiparowits region, no undergound storm drainage system needs to be provided for the majority of the new community. The street capacity for the proposed arterial, collector and local streets have been investigated and they can carry the 10 year frequency rainfall to the drainageways. In those locations where the street capacity is exceeded, drainage structures (gunite protected ditch or RCP) will take the flow to the natural drainage ways.

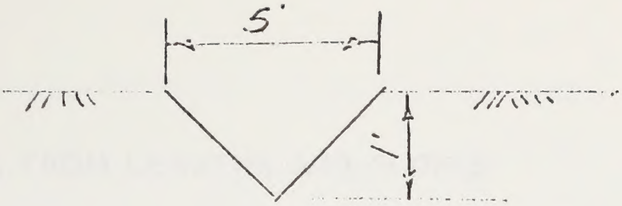
It must be emphasized that the reinforced concrete box culvert structures proposed by this study are in the nature of preliminary design only.

Final engineering calculations and plans may necessitate substituting the proposed concrete box culverts with a more efficient product.

Storm Drain Assumptions:

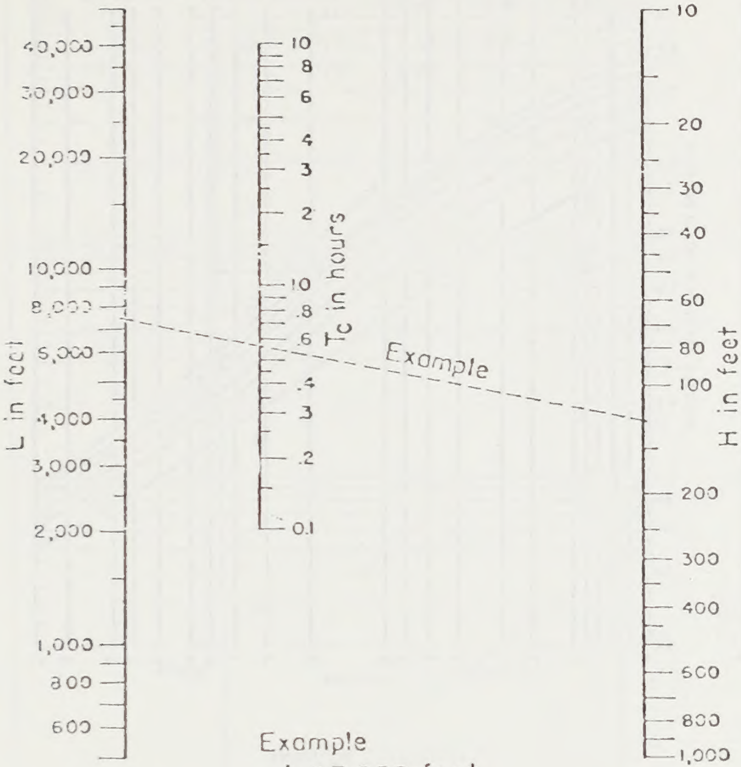
1. 3 foot earth cover over concrete box.
2. 2:1 side slopes (streets).

3. Gunite sections are:



4. Rip-rap is used; 10 feet at inlet and outlet box culverts.

C. ESTIMATING T_c FROM LENGTHS AND SLOPES:



Example
L = 7,250 feet
H = 130 feet
then T_c = 0.57 hours

(a) Nomograph (SCS Guide)

L = length of longest watercourse in feet
H = difference in elevation in feet between outlet point and divide

(b.) Solution may be made by equation from California Culverts Practice, California Highways and Public Works, September 1942.

$$T = \left(\frac{11.9\,L^3}{H}\right)^{0.385}$$

T = T_c in hours
L = length of longest watercourse in miles
H = elevation difference in feet

Lag, L, (SCS Guide) may be estimated directly for a basin by subdividing into tributary drainage subareas and using the relationship:

$$L = \frac{\Sigma a_x T_x}{A}$$, where

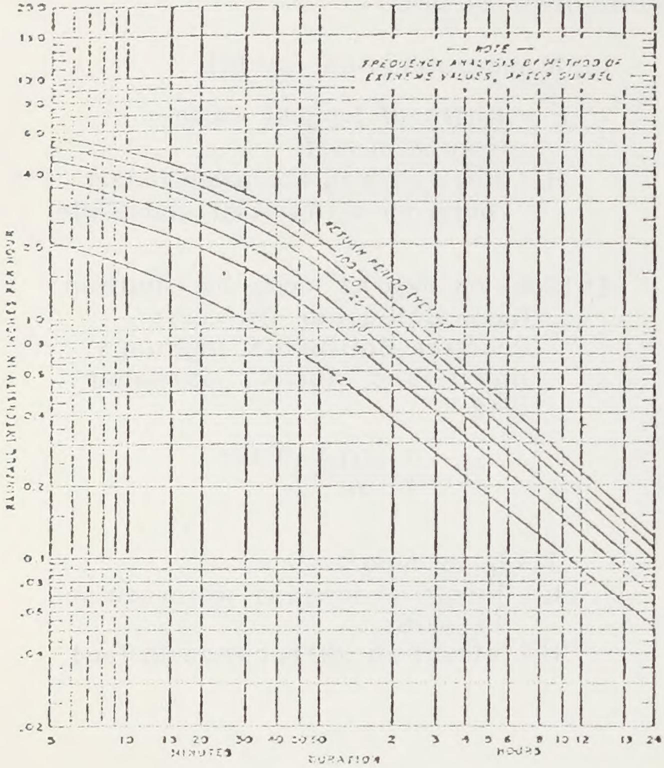
L = lag in hours
a_x = the x-th increment of area in sq. mi.
T_x = travel time in hours from center of a_x to main basin outlet
A = total area of basin, sq. mi.

Figure 13. Time of concentration estimates. (Sheet 2 of 2.)

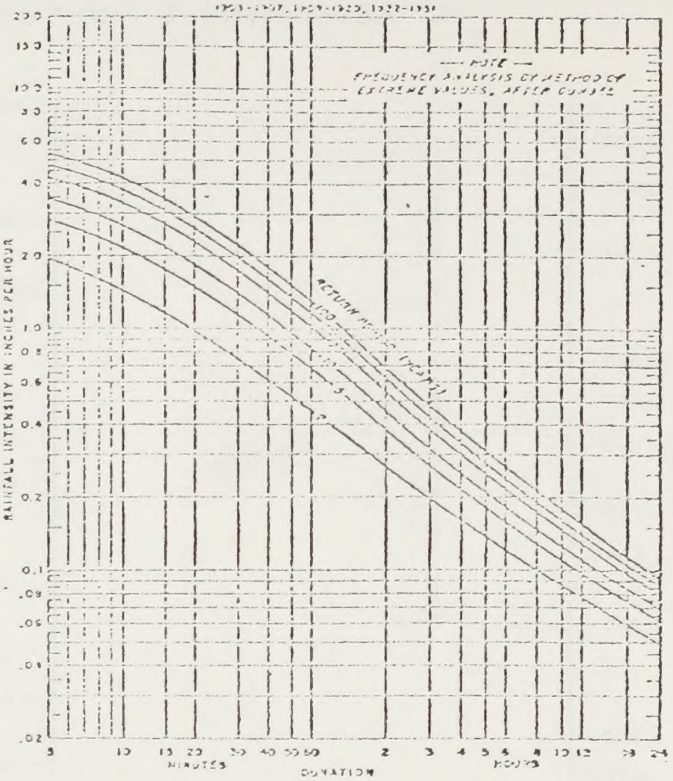
U.S. DEPARTMENT OF INTERIOR – "DESIGN OF SMALL DAMS"

RAINFALL INTENSITY-DURATION-FREQUENCY CURVES

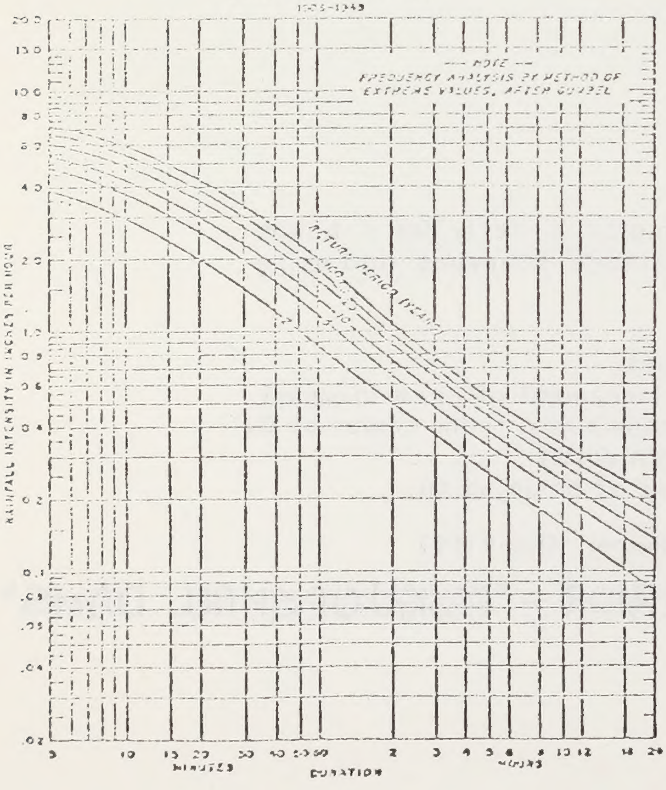
MODENA, UTAH
1904-1905, 1908-1917, 1921-1948



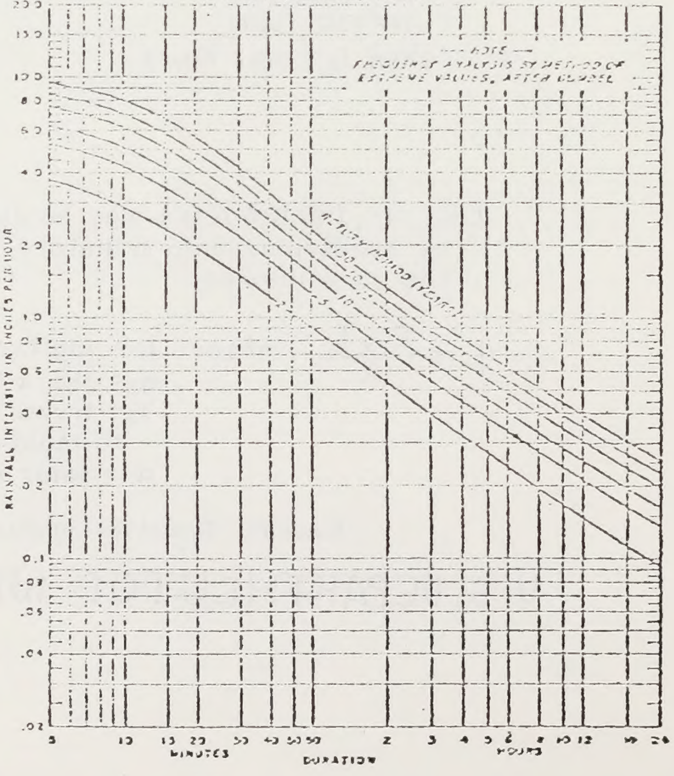
SALT LAKE CITY, UTAH
1903-1907, 1909-1920, 1922-1951

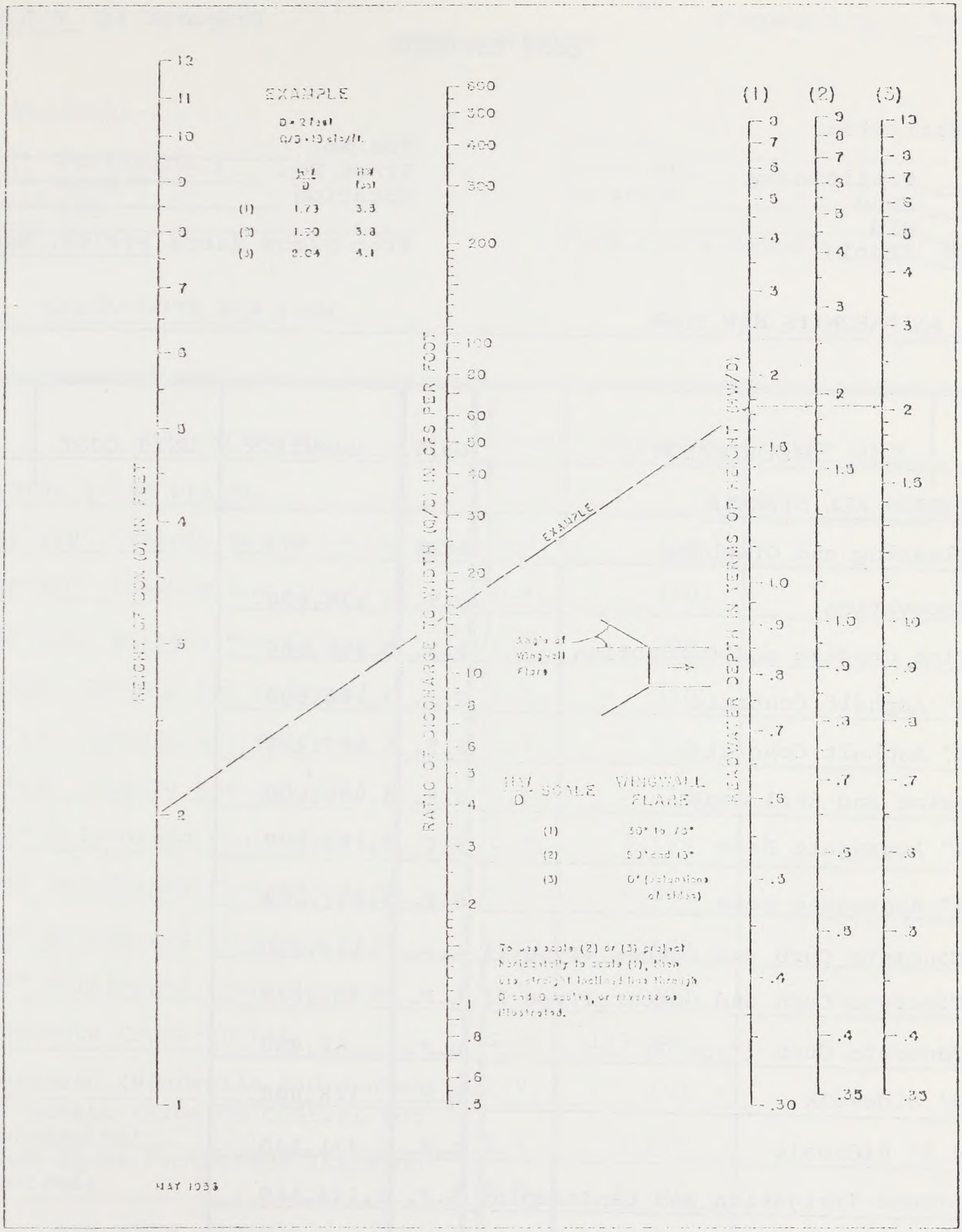


BURLINGTON, VERMONT
1905-1949



NORTHFIELD, VERMONT
1903-1914, 1920-1932, 1934-1943





HEADWATER DEPTH FOR BOX CULVERTS WITH ENTRANCE CONTROL

Plate 2.6-0619

Date November 21, 1974

Prepared by W.L.Y.

COST ESTIMATE

e of Estimate:

X Preliminary
Bond
Bid
Final

Job No.
Tract No.
Location

From Plans dated Prelim. Master Pla

LE: KAIPAROWITS NEW TOWN

EM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
	TOTALS ALL STREETS				
1.	Clearing and Grubbing	ACRE	377.3		
2.	Excavation	C.Y.	638,620		
3.	Fine Grading and Compaction	S.F.	8,996,000		
4.	3" Asphalt Concrete	S.F.	3,188,800		
5.	2" Asphalt Concrete	S.F.	5,807,200		
6.	Prime and Seal Coat	S.F.	8,996,000		
7.	9" Aggregate Base	S.F.	3,188,800		
8.	4" Aggregate Base	S.F.	5,807,200		
9.	Concrete Curb and Gutter (Type 1)	L.F.	128,000		
0.	Concrete Curb and Gutter (Type 2)	L.F.	331,840		
1.	Concrete Curb (Type 3)	L.F.	62,880		
2.	4' Sidewalk	L.F.	128,000		
3.	4.5' Sidewalk	L.F.	331,840		
4.	Street Irrigation and Landscaping	S.F.	1,144,160		
5.	Street Signs	EACH	306		
6.	Street Lights	EACH	1,533		
7.	Street Trees	EACH	320		
	SUB-TOTAL (1-17)				

Date November 21, 1974

Prepared by W.L.Y.

COST ESTIMATE

e of Estimate:

X Preliminary
Bond
Bid
Final

Job No.
Tract No.
Location

From Plans dated Prelim. Master Pla

LE: KAIPAROWITS NEW TOWN

EM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
	TOTAL STORM DRAINS				
3.	10'x10' (Triple Box Culvert)	L.F.	110		
).	10'x10' (Double Box Culvert)	L.F.	370		
).	10'x10' (Single Box Culvert)	L.F.	200		
1.	8'x8' (Double Box Culvert)	L.F.	210		
2.	8'x8' (Single Box Culvert)	L.F.	630		
3.	6'x6' (Single Box Culvert)	L.F.	110		
4.	66" Reinforced Concrete Pipe	L.F.	2,100		
5.	54" Reinforced Concrete Pipe	L.F.	4,300		
5.	36" Reinforced Concrete Pipe	L.F.	480		
7.	24" Reinforced Concrete Pipe	L.F.	300		
3.	Concrete Cross-Gutter	S.F.	115,200		
9.	Concrete (Headwalls and Wingwalls)	C.Y.	110		
).	3" Gunite (Erosion Control for Downdrains)	S.F.	2,950		
1.	Rock Slope Protection (Erosion Control)	S.F.	5,740		
	SUB-TOTAL (18-31)				
	TOTAL (1-31)				
	+10% CONTINGENCY				
	TOTAL				

Date November 21, 1974

Prepared by W.L.Y.

COST ESTIMATE

e of Estimate:

X Preliminary
___ Bond
___ Bid
___ Final

Job No.
Tract No.
Location

From Plans dated Prelim. Master Pla

LE: KAIPAROWITS NEW TOWN

EM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
	ARTERIAL STREETS				
.	Clearing and Grubbing	ACRE	78		
.	Excavation	C.Y.	209,100		
.	Fine Grading and Compaction	S.F.	1,886,400		
.	3" Asphalt Concrete	S.F.	1,886,400		
.	Prime and Seal Coat	S.F.	1,886,400		
.	9" Aggregate Base	S.F.	1,886,400		
.	Concrete Curb and Gutter (Type 1)	L.F.	62,880		
.	Concrete Curb (Type 3)	L.F.	62,880		
.	4' Sidewalk	L.F.	62,880		
.	Street Irrigation and Landscaping	S.F.	786,000		
.	Street Signs	EACH	54		
.	Street Lights	EACH	210		
.	Street Trees	EACH	158		
	SUB-TOTAL (1-13)				
	ARTERIAL STREET STORM DRAINS				
.	10'x10' (Triple Box Culvert)	L.F.	110		
.	10'x10' (Double Box Culvert)	L.F.	220		

Date November 21, 1974

Prepared by W.L.Y.

COST ESTIMATE

e of Estimate:

X Preliminary
Bond
Bid
Final

Job No.
Tract No.
Location

From Plans dated Prelim. Master P

LE: KAIPAROWITS NEW TOWN

EM	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
.	8'x8' (Double Box Culvert)	L.F.	110		
.	8'x8' (Single Box Culvert)	L.F.	330		
.	6'x6' (Single Box Culvert)	L.F.	110		
.	36" Reinforced Concrete Pipe	L.F.	330		
.	Concrete Cross Gutter	S.F.	9,500		
.	3" Gunite (Erosion Control for Downdrains)	S.F.	1,050		
.	Rock Slope Protection (Erosion Control)	S.F.	2,500		
	SUB-TOTAL (14-22)				
	TOTAL (1-22)				
	+10% CONTINGENCY				
	TOTAL				

Date November 21, 1974

Prepared by W.L.Y.

COST ESTIMATE

of Estimate:

X Preliminary
___ Bond
___ Bid
___ Final

Job No. __________
Tract No. __________
Location __________

From Plans dated Prelim. Master Pla

: KAIPAROWITS NEW TOWN

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
COLLECTOR STREETS				
Clearing and Grubbing	ACRE	37.5		
Excavation	C.Y.	66,240		
Fine Grading and Compaction	S.F.	883,200		
3" Asphalt Concrete	S.F.	883,200		
Prime and Seal Coat	S.F.	883,200		
9" Aggregate Base	S.F.	883,200		
Concrete Curb and Gutter (Type 1)	L.F.	44,160		
4' Sidewalk	L.F.	44,160		
Street Irrigation and Landscaping	S.F.	242,880		
Street Signs	EACH	54		
Street Lights	EACH	147		
Street Trees	EACH	110		
SUB-TOTAL (1-12)				
COLLECTOR STREET STORM DRAINS				
10'x10' (Double Box Culvert)	L.F.	100		
10'x10' (Single Box Culvert)	L.F.	100		
8'x8' (Single Box Culvert)	L.F.	100		

Date November 21, 1974

Prepared by W.L.Y.

COST ESTIMATE

of Estimate:

X Preliminary
Bond
Bid
Final

Job No.
Tract No.
Location
From Plans dated Prelim. Master Plan

E: KAIPAROWITS NEW TOWN

M	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
	36" Reinforced Concrete Pipe	L.F.	150		
	24" Reinforced Concrete Pipe	L.F.	300		
	Concrete Cross-Gutter	S.F.	15,200		
	Concrete (Headwalls and Wingwalls)	C.Y.	20		
	3" Gunite (Erosion Control for Downdrains)	S.F.	500		
	Rock Slope Protection (Erosion Control)	S.F.	580		
	SUB-TOTAL (13-21)				
	TOTAL (1-21)				
	+10% CONTINGENCY				
	TOTAL				

Date November 21, 1974

Prepared by W.L.Y.

COST ESTIMATE

of Estimate:

X Preliminary
____ Bond
____ Bid
____ Final

Job No. ____
Tract No. ____
Location ____

From Plans dated Prelim. Master Plan

E: KAIPAROWITS NEW TOWN

M	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
	INDUSTRIAL STREETS				
	Clearing and Grubbing	ACRE	17.8		
	Excavation	C.Y.	31,440		
	Fine Grading and Compaction	S.F.	419,200		
	3" Asphalt Concrete	S.F.	419,200		
	Prime and Seal Coat	S.F.	419,200		
	9" Aggregate Base	S.F.	419,200		
	Concrete Curb and Gutter (Type 1)	L.F.	20,960		
	4' Sidewalk	L.F.	20,960		
	Street Irrigation and Landscaping	S.F.	115,280		
	Street Signs	EACH	28		
	Street Lights	EACH	70		
	Street Trees	EACH	52		
	SUB-TOTAL (1-12)				
	INDUSTRIAL STREET STORM DRAINS				
	8'x8' (Single Box Culvert)	L.F.	200		
	Rock Slope Protection (Erosion Control)	S.F.	960		
	Concrete Cross-Gutter	S.F.	2,000		

Date November 21, 1974

Prepared by W.L.Y.

COST ESTIMATE

of Estimate:

X Preliminary
Bond
Bid
Final

Job No.
Tract No.
Location
From Plans dated Prelim. Master Pla

E: KAIPAROWITS NEW TOWN

	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
	3" Gunite (Erosion Control for Downdrains)	S.F.	400		
	SUB-TOTAL (13-16)				
	TOTAL (1-16)				
	+10% CONTINGENCY				
	TOTAL				

Date November 21, 1974

Prepared by W.L.Y.

COST ESTIMATE

of Estimate:

X Preliminary
___ Bond
___ Bid
___ Final

Job No.
Tract No.
Location

From Plans dated Prelim. Master Pl

E: KAIPAROWITS NEW TOWN

	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
	LOCAL STREETS				
	Clearing and Grubbing	ACRE	244		
	Excavation	C.Y.	331,840		
	Fine Grading and Compaction	S.F.	5,807,200		
	2" Asphalt Concrete	S.F.	5,807,200		
	Prime and Seal Coat	S.F.	5,807,200		
	4" Aggregate Base	S.F.	5,807,200		
	Concrete Curb and Gutter (Type 2)	L.F.	331,840		
	4.5' Sidewalk	L.F.	331,840		
	Street Signs	EACH	170		
	Street Lights	EACH	1,106		
	SUB-TOTAL (1-10)				
	LOCAL STREETS STORM DRAINS				
	10'x10' (Double Box Culvert)	L.F.	50		
	10'x10' (Single Box Culvert)	L.F.	100		
	8'x8' (Double Box Culvert)	L.F.	100		
	66" Reinforced Concrete Pipe	L.F.	2,100		
	54" Reinforced Concrete Pipe	L.F.	4,300		

Date November 21, 1974

Prepared by W.L.Y.

COST ESTIMATE

of Estimate:

X Preliminary
Bond
Bid
Final

Job No.
Tract No.
Location
From Plans dated Prelim. Master Plan

: KAIPAROWITS NEW TOWN

1	DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
	Concrete Cross-Gutter	S.F.	88,500		
	Concrete (Headwalls and Wingwalls)	C.Y.	90		
	3" Gunite (Erosion Control for Downdrains)	S.F.	1,000		
	Rock Slope Protection (Erosion Control)	S.F.	1,700		
	SUB-TOTAL (11-19)				
	TOTAL (1-19)				
	+10% CONTINGENCY				
	TOTAL				

G. Water Supply System

1. Supply:

The preferable and anticipated source of water supply for this project is deep wells. The wells are to be located on or near the site. At the present time, no test drilling has been undertaken; therefore, the quality and quantity are unknown factors. Pilot holes should be drilled as soon as the town site has been finalized.

Should the quality or quantity of well water be unsatisfactory, an alternate supply source would be from the feeder line to the plant. This would require a transmission line from Nipple Bench to the town site. Both water sources will require the construction of a treatment plant.

2. Treatment:

Treatment facilities capable of 10 M.G.D. will be required to process the water before distribution in the system.

3. Distribution System:

A water piping system divided into two zones will be necessary to meet the demands of this town site. Each zone will consist of 24" to 4" piping system capable of delivering peak hour demand or live flow requirements.

Pipe is to be installed with 30" to 36" of cover; this should be adequate for frost protection in this area.

4. Storage:

Each water zone will have storage facilities with a capacity of one maximum day demand plus live flow requirements. Due to the present day shortage of some construction materials such as steel, the final form or manner in which the storage facilities are constructed will depend upon environmental and economic considerations.

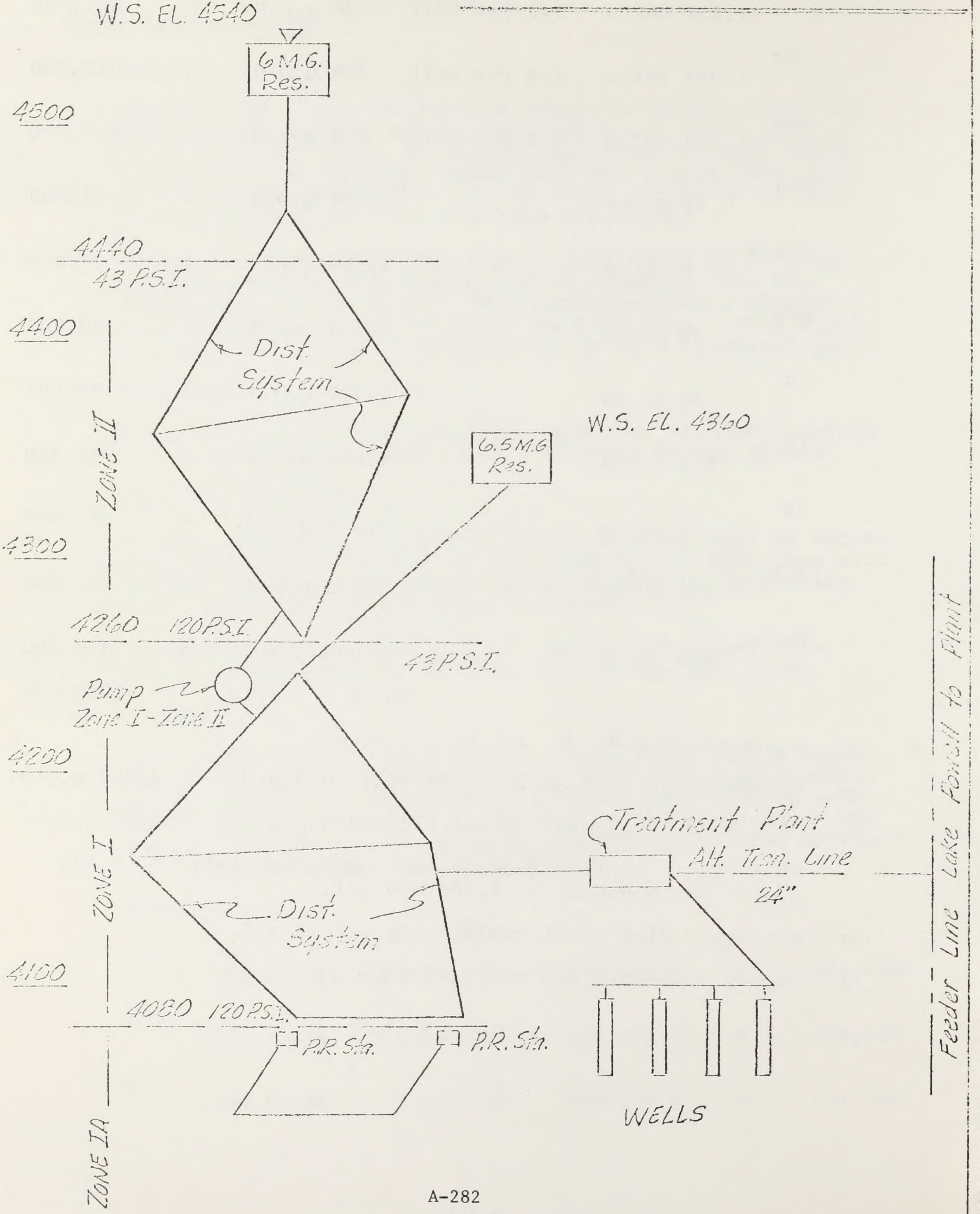
5. Water Demand:

GAC					
	256 Units	3.0 Per Unit	160 g.p.d.	=	123,000
TDF					
	504 Units	3.5 Per Unit	180 g.p.d.	=	318,000
SFC					
	748 Units	3.5 Per Unit	200 g.p.d.	=	524,000

SFD					
	1,230 Units	3.5 Per Unit	200 g.p.d.	=	861,000
MHC					
	1,021 Units	3.5 Per Unit	200 g.p.d.	=	715,000
MHP					
	1,380 Units	3.0 Per Unit	150 g.p.d.	=	621,000
C-1					
	12 Acres		4,500 g.p.d.	=	54,000
C-1-A					
	6 Acres		4,500 g.p.d.	=	27,000
C-2					
	20 Acres		4,500 g.p.d.	=	90,000
CH					
	21 Acres		4,500 g.p.d.	=	95,000
LI					
	165 Acres		6,000 g.p.d.	=	990,000
PS					
	58 Acres		2,000 g.p.d.	=	116,000
Sch					
	121 Acres		2,000 g.p.d.	=	242,000
Parks					
	235 Acres		2,000 g.p.d.	=	470,000
			TOTAL - g.p.d.		5,246,000

- 5,246,000 g.p.d. = 3,640± g.p.m. ave.
- Maximum day = 2 ave. = 10,452,000 g.p.d. = 7,280 g.p.m.
- Peak hour = 5 ave. = 26,230,000 g.p.d. = 18,200 g.p.m.
- Fire flow - maximum (commercial and industrial) = 5,000 g.p.m. @ 5 hours = 1,500,000 gal.
- Storage - fire + 1 maximum day = 12 M.G.
- Supply - maximum day = 7,280 g.p.m.

WATER VERTICAL SCHEMATIC



WATER QUANTITIES

ZONE I

Item	Description	Quantity	Unit	Unit Price	Cost
1	6.5 M.G. Res.	1	EACH		
2	24" Pipe	3,500	L.F.		
3	18" Pipe	3,100	L.F.		
4	16" Pipe	5,000	L.F.		
5	12" Pipe	28,000	L.F.		
6	10" Pipe	7,800	L.F.		
7	8" Pipe	31,000	L.F.		
8	6" Pipe	18,700	L.F.		
9	4" Pipe	6,500	L.F.		
10	24" Valve	1	EACH		
11	18" Valves	2	EACH		
12	16" Valves	3	EACH		
13	12" Valves	18	EACH		
14	10" Valves	10	EACH		
15	8" Valves	50	EACH		
16	6" Valves	40	EACH		
17	4" Valves	35	EACH		
18	Fire Hydrants	200	EACH		
19	Air Vac Valves	20	EACH		
20	Blow-off	50	EACH		
21	Wells	4	EACH		
22	Service Connections	2,000	EACH		

Water Quantities - Zone I (Con't.)

Item	Description	Quantity	Unit	Unit Price	Cost
23	Press. Red. Sta.	2	EACH		
24	Tele. Control System	1	EACH		
25	Treatment Plant	1	EACH		
		SUB-TOTAL - ZONE I			
		+10% CONTINGENCY			
		TOTAL			

WATER QUANTITIES
ZONE II

Item	Description	Quantity	Unit	Unit Price	Cost
1	24" Pipe	1,100	L.F.		
2	18" Pipe	6,500	L.F.		
3	16" Pipe	6,000	L.F.		
4	14" Pipe	3,500	L.F.		
5	12" Pipe	21,000	L.F.		
6	10" Pipe	18,000	L.F.		
7	8" Pipe	55,000	L.F.		
8	6" Pipe	19,000	L.F.		
9	4" Pipe	6,000	L.F.		
10	24" Valve	1	EACH		
11	18" Valves	2	EACH		
12	16" Valves	4	EACH		
13	12" Valves	16	EACH		
14	10" Valves	20	EACH		
15	8" Valves	40	EACH		
16	6" Valves	40	EACH		
17	4" Valves	35	EACH		
18	Fire Hydrants	270	EACH		
19	Air Vac Valves	25	EACH		
20	Blow-offs	60	EACH		
21	Pump (Zone I to II)	1	EACH		
22	Service Connections	3,000	EACH		

Water Quantities - Zone II (Con't.)

Item	Description	Quantity	Unit	Unit Price	Cost
23	Tele. Control System	1	EACH		
24	6.0 M.G. Res.	1	EACH		
		SUB-TOTAL - ZONE II			
		+10% CONTINGENCY			
		TOTAL			

WATER QUANTITIES

(ALTERNATE SUPPLY FROM PLANT FEEDER MAIN LINE)

Item	Description	Quantity	Unit	Unit Price	Cost
1	Wells	-4	EACH		
2	24" Pipe	+37,000	L.F.		
		SUB-TOTAL - ALTERNATE SUPPLY			
		+10% CONTINGENCY			
		TOTAL			

H. Sewage Collection and Disposal System

1. Collection System:

The East Clark Bench sewage collection system will be composed of 8" to 18" gravity mains. One pump station is anticipated in the collection system. The system will transport the sewage to one treatment plant site.

2. Treatment:

The treatment plant is to be a conventional activated sludge process. The treatment is to meet the State Health Department standards and recommendations. The precise location of the treatment plant cannot be determined until expanded topography is available. It may indicate separating the projected volumes into two treatment plants.

3. Disposal:

The effluent will be pumped to an area set aside for irrigation. It may be possible to raise crops of alfalfa or pasture grass or similar crops.

Alternate methods of disposal may be irrigation of the golf course or evaporation and percolation ponds.

4. Flow Quantities:

The estimated average daily flow is 3.5 M.G.D.

SEWAGE FLOW

Land Use	Averaged Acreage	Dwelling Units	Flow Rate	C.F.S.
GAC	32	256	.00039	0.100
TDF	84	504	.00046	0.232
SFC	208	748	.00046	0.344
SFD	481	1,230	.00046	0.566
MHC	292	1,021	.00046	0.470
MHP	242	1,380	.00039	0.538
C-1	12		.006	0.072
C-1-A	6		.006	0.036
C-2	20		.006	0.120
CH	21		.006	0.126
LI	165		.008	1.320
CC	32		.006	0.192
H	11		.035	0.385
ES	44		.005	0.220
JH	30		.006	0.180
SH	40		.007	0.280
PH	7		.005	0.035
CRC	30		.006	0.180
NP	23		.0003	0.007
RRC	11		.006	0.066
GC	160		.0003	0.048
			TOTAL - C.F.S.	5.517

- Average:

5.517 c.f.s. = 2,475 g.p.m.
= 3.5 M.G.D.

- Peak Factor 2.25:

5.517 x 2.25 = 12.4 c.f.s.
= 5,570 g.p.m.

SANITARY SEWER SYSTEM

Item	Description	Quantity	Unit	Unit Price	Cost
1	Treatment Plant - 3.5 M.G.D.	1	EACH		
2	18" Main	15,000	L.F.		
3	15" Main	2,000	L.F.		
4	12" Main	14,000	L.F.		
5	10" Main	12,000	L.F.		
6	8" Main	188,000	L.F.		
7	Manholes	800	EACH		
8	Service Connections	5,000	EACH		
9	Pump Station	1	EACH		
10	Force Main	100	L.F.		
11	Effluent Pump Station	1	EACH		
12	Holding Ponds	3	EACH		
13	Effluent Line - 14"	7,500	L.F.		
14	Irrigated Disposal	60	ACRE		
		SUB-TOTAL			
		+10% CONTINGENCY			
		TOTAL			

I. Airport

Additional studies will be required to investigate the necessity and location of any airport to be constructed in connection with the new community. Due to the preliminary nature of this item, an assumption was made to determine preliminary quantities and costs. It is assumed that in order to land commercial type aircraft, two runways will be required, one of ±10,000 feet in length and one of ±6,000 feet in length. It is further estimated that the corresponding taxiways would be two-thirds of the runway lengths. Since drainage is critical to a functional airport, an estimate of approximate quantities relative to this item are included. Items such as control tower, landing systems, etc. are not included in the estimate.

AIRPORT

PRELIMINARY COST ESTIMATE

Item	Description	Quantity	Unit	Unit Price	Cost
1	Excavation	269,000	C.Y.		
2	6" A.C. Surfacing	2,400,000	S.F.		
3	12" Aggregate Base	2,400,000	S.F.		
4	12" Aggregate Subbase	2,400,000	S.F.		
	Taxiway				
1	6" A.C. Surfacing	750,000	S.F.		
2	8" Aggregate Base	750,000	S.F.		
3	6" Aggregate Subbase	750,000	S.F.		
	Storm Drains				
1	Catch Basins	150	EACH		
2	36" Reinforced Concrete Pipe	6,800	L.F.		
3	30" Reinforced Concrete Pipe	9,600	L.F.		
4	24" Reinforced Concrete Pipe	10,800	L.F.		
5	18" Reinforced Concrete Pipe	3,600	L.F.		
6	Concrete	100	C.Y.		
7	Rock Slope Protection	1,100	S.F.		
		SUB-TOTAL			
		+10% CONTINGENCY			
		TOTAL			

J. Solid Waste Disposal

It is tentatively proposed that a sanitary land fill be utilized as the means of disposing of solid waste. Prior to determining the precise location of the solid waste site, a soils and geology investigation of the area must be accomplished. Due to the preliminary nature of this item, the 200± acres mentioned in the Brigham Young University Report is sufficient for the area needed for a solid waste site; as the master plan is further refined, the volumes expected to be generated can also be refined.

COMPARATIVE MILEAGES AND DRIVING TIMES

	Number of Miles			Driving Time (Minutes) One Way		
Potential Town Sites	Mine	Nipple Bench Plant Site	Four Mile Bench Plant Site	Mine	Nipple Bench Plant Site	Four Mile Bench Plant Site
East Clark Bench	20.2	13.8	27.4	26.3 (46.1 mph)	18.9 (43.8 mph)	36.5 (45.0 mph)
Butler Valley	25.7	34.3	14.7	34.8 (44.3 mph)	45.4 (45.3 mph)	18.8 (46.9 mph)
Long Flat	19.8	28.4	8.8	26.6 (44.6 mph)	37.2 (45.8 mph)	10.6 (50.0 mph)
Four Mile Bench	9.1	17.7	1.5	13.7 (40.0 mph)	24.3 (43.7 mph)	2.3 (40.0 mph)
Nipple Bench	12.4	1.0	19.6	16.4 (45.4 mph)	1.5 (40.0 mph)	26.6 (44.2 mph)
"Competitive" Areas						
Cannonville	40.3	48.9	29.3	52.3 (46.2 mph)	62.9 (46.6 mph)	36.3 (48.4 mph)
Kanab	75.2	68.8	82.4	81.3 (55.5 mph)	73.9 (55.9 mph)	91.5 (54.0 mph)
Page, Arizona	36.2	29.8	43.4	44.7 (48.6 mph)	37.3 (47.9 mph)	54.9 (47.4 mph)
Arizona - Greene's proposed project	28.5	22.1	35.7	34.6 (49.4 mph)	27.2 (48.7 mph)	44.8 (47.8 mph)

Note: Mileages are preliminary and approximately 9 percent less than those estimated by Highway Department in their November 1974 report; subject to further review.

Source: Development Economics, Inc.

PRELIMINARY SCHEDULE OF EMPLOYMENT REQUIREMENTS

	Generating Station				Coal Mine			Total Generating Station and Mine	Limestone Quarry		
	Construction										
Time (Years) 1/	Manual	Non-Manual 2/	Operation	Total	Construction	Operation 3/	Total		Construction	Operation	Grand Total
1	505	90	-	595	100	-	100	695	36	30	761
2	1,132	150	-	1,282	300	55	355	1,637	-	30	1,667
3	1,813	248	-	2,061	500	220	720	2,781	-	30	2,811
4	2,144	261	150	2,555	700	523	1,223	3,778	-	65	3,843
5	1,961	260	150	2,371	600	919	1,519	3,890	-	65	3,955
6	1,621	196	350	2,167	400	1,320	1,720	3,887	-	65	3,952
7	960	142	450	1,552	300	1,870	2,170	3,722	-	65	3,787
8	144	82	510	736	200	2,585	2,785	3,521	-	65	3,586
9	61	74	510	645	-	2,695	2,695	3,340	-	65	3,405

1/ Projections are for year end employment levels.
2/ Excludes Southern California Edison supervisory personnel which will total 35 employees at the peak of construction employment.
3/ Includes a 10 percent allowance for absentees.

Sources: Southern California Edison Unofficial Estimates derived from various reports, and Development Economics, Inc.

APPENDIX I-12

Kaiparowits Access Road Study, Kaiparowits Planning and Development Council

five county association of governments

POST OFFICE BOX 261
CEDAR CITY, UTAH 84720
PHONE 586-4842, 586-9986

November 21, 1974

Mr. Frank Snell
EIS Core Team
Federal Building Annex
135 South State Street
Salt Lake City, Utah 84111

Dear Mr. Snell,

For some weeks the Kaiparowits Planning and Development Council, through its Access - Highways Work Group, has been studying and developing alternatives for an access system related to the Kaiparowits Power Project. The Work Group submitted its formal recommendations to the Planning and Development Council for consideration and approval on November 18.

The Planning and Development Council and Executive Committee approved the recommendations of the Work Group on November 18. We now formally submit the following basic action proposal and alternatives for access - highways development to the B.L.M. for input into the Environmental Impact Statement.

It is the basic action proposal of the Planning and Development Council that:

1. The Access - highways system planned and constructed to support the Kaiparowits Power Project and proposed New Community should be a 'through system' from Cannonville in Garfield County (on the North) to the Glen Canyon City (East Clark Bench - New Community Site) on the South - U.S. 89.

2. The 'through' access system for the Fourmile Bench Plant site should include road segments B.1, B.6, and B. 10. (See page 16 - attached materials)

3. The 'through' access system for the Nipple Bench Plant site should include road segments B.1, B.6, B.10, and C. 1. (See Page 16 - attached materials)

4. This 'through' access system will serve either the New Community site at East Clark Bench (action proposal) or Butler Valley (alternative).

In the attached materials four 'access road alternatives' are described and defined, one of which is the one approved as the Council's action proposal. We submit the other three access road alternatives (Pages 15, 17, 18) as alternatives to the basic action proposal B.1, B.6, B.10, and C.1 system for purposes of the Environmental Impact Statement.

BEAVER GARFIELD IRON KANE WASHINGTON

Based on our previous discussion with EIS Core Team members, we trust that this report of action taken by the Council and the submittal of the attached material will meet the access - highways information needs for the EIS. If further information of clarification of action is needed, please contact the Council as soon as possible.

We have greatly appreciated the cooperation of the EIS Core Team in our efforts to develop the access - highways action proposal and alternatives, and shall look forward to that same cooperation in the future.

Sincerely,

Merrill R. MacDonald
Chairman

cc: Morgan Jensen
James Biggins

KAIPAROWITS POWER PLANT ACCESS ROAD
LOCATION AND FEASIBILITY STUDY
NOVEMBER 15, 1974

A. General

This Study can be broken into three basic units: written data on the area and the alternates (Pages 1 through 8), tabular data showing comparisons between alternates (Pages 9 through 14) and area maps which display the alternates (following Page 14). The Utah State Department of Highways, under the direction of the Utah State Road Commission, is acting on behalf of Kane and Garfield Counties in the preparation of this Study. Final roadway design, construction and maintenance responsibility will be determined at a later date depending on funding source and jurisdictional responsibility. Detailed roadway design should not start until the plant site is determined or the access road alternate selected.

Based on the fact that all access road alternates outlined herein are relatively long in length and quite expensive, it may be desirable to award two or more construction projects for the selected alternate. There are advantages to this procedure as compared with awarding one construction contract for all access roads required. A single contract would be of such magnitude in scope of work and cost that many potential contractors could not, or would not, bid on the project. Two, or more, contracts could be awarded and built almost simultaneously. It is anticipated that the first contract could be awarded approximately one year after go-ahead is given for design on a final access road alternate. Each contract will probably take 12 to 18 months to complete. Prior to award of any highway construction contracts, some preliminary grading should be performed so that plant construction personnel can get their equipment to the selected plant site.

There appear to be three basic destination points which must be connected by a road network, i.e., the power plant, the coal mine and a community. This community, whether new or not, will provide the residences for the majority of the people working at the plant and coal mine. The major uses for the access roads are expected to be as follow:

1. Power Plant Access. Two power plant sites, one at Fourmile Bench and one at Nipple Bench, have been given consideration in this Study. It is expected that as many as 2,500 people will be working on the plant at the height of its construction. After completion, slightly over 500 people will be required to operate the plant. Although access roads may not adequately serve the construction force for the first year or two, they should be completed and available before the height of construction is reached.

2. Coal Mine Access. Normal mine operation is expected to require 2,100 workers who will require a good quality access facility. It is expected that these 2,100 workers will be divided into three working shifts (two operational and one maintenance).

3. Community Access. It is anticipated that over 4,000 additional jobs will be generated to provide support for the power plant plus mine employees and their families. This community will also require high quality access to and from the existing State Highway System. Due to its nearness to the Glen Canyon Recreation Area, this community will undoubtedly also serve as a hub for recreational activities by providing motels, restaurants, sales outlets for

recreation equipment and other such facilities to entice visits by recreation-oriented people from all across the country. Therefore, the size of this community may consist of from 15,000 to 20,000 people. Such a community would be the largest city for hundreds of miles in any direction. One proposal specifies a new community in the Clark Bench Area (west of Glen Canyon City) while another places the town site at Butler Valley, near Grosvenor's Arch. Although other town sites have been evaluated, the above two are the only sites which seem to be receiving serious consideration at this time. It is anticipated that some employees will reside in Page, Arizona while others will reside in the Cannonville-Tropic area. However, a large majority of the employees are expected to reside in the new community.

4. Recreation Traffic. Any, or all, of the access road alternates being considered could provide access to many areas of interest to recreationists. Backpackers, sightseers, campers and water enthusiasts are some of the types of individuals who might be interested in travelling on the access road alternates under study.

5. Maintenance Road. Portions of each access road alternate may also serve as a maintenance road for such plant auxiliary items as the coal conveyor line, the water pipeline and the electrical transmission lines. Each of these different lines will require at least a low-grade maintenance road and, in those areas where the access road is in close proximity, it should be able to serve the dual function of area access and facility maintenance.

In addition to the employees working at the plant, the mine and the community itself, there will be others working for a limestone trucking operation. It has been estimated that 30 trucks per day for six days a week will be required to provide limestone for the emission control system at the power plant. The limestone quarry is located north of Bryce Canyon and the truck route is expected to pass through the Cannonville-Tropic area.

Even if the Clark Bench or Butler Valley site is selected for the new community, it is expected that approximately 5% of the plant-mine employees will still desire to live in the Cannonville-Tropic area. This desire will be predicted on the availability of adequate supporting facilities, i.e., culinary water, sewage system, utilities, schools, shopping areas, etc. By combining the employees from the trucking operation with 5% of the plant-mine employees, an estimate of 150 new families (450-500 people) may be added to the existing population in the Cannonville-Tropic area. Paragraph D. considers road user costs for the various access road alternates addressed in this Study. No attempt has been made to calculate road user costs for the Cannonville-Tropic commuters just mentioned. Their desire would undoubtedly be for the most direct route possible to their place of work. It is of interest to note that actions are now under way in Garfield County to provide the necessary support facilities for the Cannonville-Tropic area to accommodate the new community should such a course of action be in the best interest of all parties concerned.

The highest volume of traffic on each access road alternate will occur during the typical rush hours created by commuters going to and returning from work. At other times of the day, the access roads should see only limited use. An analysis of the expected traffic volumes and the design standards of the Utah Department of Highways indicate that a 34-foot wide road (two 11-foot lanes and two 6-foot shoulders) should be adequate. Paragraph D. of this Study goes into further detail on the projected traffic volumes and their use in calculating road user costs. Many of the access road alternates will involve relatively long commuting distances (over 30 miles one-way in some instances). It is, therefore, very desirable to have a roadway facility which would allow a reasonable speed (40-50 mph) so as to keep commuting time from becoming excessive. Long grades in excess of 6% should be avoided, if possible, as they drastically affect the speeds of large trucks; and they are hazardous to drive and hard to maintain in winter weather.

Even though the average annual precipitation on the benches ranges from 6 to 10 inches, flash flooding is not at all uncommon due to the types of storms, the lack of dense vegetation and the types of soils and rock formations found in the area. Accordingly, each access road alternate will require some relatively expensive hydraulic structures to prevent road damage during flash floods. The cost estimates included herein for access roads have given consideration to the local hydraulic problems.

Rivers and streams which might be traversed by one or more of the access road alternates flow little or no water during the hot, dry summer months. In addition, many of the stream beds show evidence of high alkali concentrations in the water. It is, therefore, not surprising that these drainages do not provide a fishery.

Some of the more abundant wildlife in the area include mule deer, cottontail rabbits, mourning dove, quail, mountain lion, bobcat and coyote. Due to the sparse vegetation and lack of water in the area, these species are no more abundant than one might expect in a desert. The most abundant form of animal life which greets a visitor to the area is range cattle, and even they are not in great numbers.

A problem common to this general area is the lack of sources of good quality aggregate, or gravel. Wahweap Creek and Horse Mountain (located at the north edge of Fourmile Bench) appear to be the only sources in the immediate area which can supply an aggregate which is both of good quality and sufficient quantity for major construction projects. Aggregate from Wahweap Creek was used in the construction of Glen Canyon Dam (approximately 17 miles to the southwest). Preliminary estimates of total aggregate requirements for each alternate are included in Tables I and IV on Pages 9 and 12, respectively. These estimates are based on the need for 12,000 cubic yards of aggregate per mile for use in the surfacing and as untreated base course.

Information obtained for this Study indicates the coal mine operations complex to be generally located in Sections 3 and 4 of Township 41 South, Range 3 East, Salt Lake Base and Meridian. This location would serve both the Fourmile and Nipple Bench sites.

Most canyons in the area follow a winding route and are characterized by narrow bottoms with steep to vertical side slopes (generally averaging one to one side slopes). Wahweap and Nipple Creeks are in the only canyons which really deviate from the characteristics described above. Wahweap Creek is different in that it flows in a relatively straight, wide bottomed canyon for most of its route, and Nipple Creek does not have the steep, high canyon walls that are typical in the other canyons. For this Study, an attempt was made on each alternate to hold heavy cuts and fills at a minimum and to leave the terrain in its existing condition wherever possible. All alternate locations, as indicated on the maps in this Study, are subject to minor change during detailed design. Time and appropriate mapping will then be available to allow the highway designers to set the horizontal and vertical alignments in such a way as to further minimize deep cuts, deep fills, stream encroachments and damage to any other aesthetically pleasing features.

The Tables, starting on Page 9, show the alternate access roads which would provide the required access for the plant, the mine and the community. The estimated costs included herein have taken into consideration both the heavy truck loads and inflation to date. It is entirely possible that other combinations of the segments outlined in this Study can be used to make additional alternatives, which may be as viable as those listed. There are many other canyons which could serve as alternate routes in providing access to Fourmile Bench. However, those routes which appeared most reasonable were given consideration. From the information obtained, it appears that some of the alternates evaluated and described herein are bordering on the unrealistic. Many canyons not selected for study have advantages, and disadvantages, similar to those that were selected. Even though the area is generally mountainous, its arid nature basically brings it into a desert-type category. Wildlife and plant life populations are sparse unless compared with similar desert-type situations, and then the populations would probably be classed as average. Although, when first viewed, the terrain is interesting to look upon, it does have a tendency to become monotonous to many individuals upon staying in the area for a length of time. Due to the relative vastness of the area, the access roads can be designed and constructed in such a way as to make them blend in with or be hidden by the surrounding country. Normal procedures include watering of unpaved highways during construction. This action will help minimize the negative impact created by dust for those using the highway or viewing the area from a distance.

B. Fourmile Bench Access Roads

Fourmile Bench is accessible from Cannonville by a generally well-graded dirt road. This existing route will provide adequate fair-weather access to the Fourmile Bench site for the plant construction crews and equipment. Access to the coal mine will be via narrow 4-wheel drive jeep trails until considerable leveling and widening is performed on these trails by a grader or until an adequate paved road can be constructed. It is desirable to have access to the plant site from both the north (Cannonville and State Route 12) and the south (Glen Canyon City and U.S. 89). Accordingly, all of the alternates will provide access from both directions. The segments of the access road alternates for the Fourmile Bench site are:

1. Cannonville to Fourmile Bench. This piece of existing dirt road is approximately 34.8 miles long. It passes through grasslands and cultivated fields for the majority of the distance between Cannonville and Grosvenor's Arch. The section from Grosvenor's Arch to the Fourmile Bench site passes through areas of light brush and light-to-medium concentrations of junipers. Included in this segment would be some 39 stream crossings and a maximum grade of 8% for approximately one mile of the total distance. Except for the few sections of 8% grade, the vertical alignment would traverse gently rolling terrain with all other grades being less than 6%. One of the few areas of heavy construction on this segment of highway would be through the area known as "The Gut" which is adjacent to Grosvenor's Arch. The geologic formations are steeper at this point and would require some short sections of moderate cuts and fills. Aggregate sources can be obtained from Wahweap Creek, Paria River, the hills of Round Valley and on Horse Mountain. The estimated cost for this segment is $14,500,000.

2. U.S. 89, west of Glen Canyon City to Grosvenor's Arch via Cottonwood Creek. This 28.7 mile segment begins on U.S. 89, approximately 11 miles west of Glen Canyon City. Gently rolling terrain is found throughout this segment accompanied by only light brush and light juniper cover. All vertical grades would be less than 4% and 20 stream crossings would be encountered. Most of this segment is also occupied by high power electrical lines. Aggregate sources would be available from Paria River, Horse Mountain and Wahweap Creek. The estimated cost for this segment is $9,700,000.

3. Glen Canyon City to Cannonville Road via Wahweap Creek and Tommy Smith Creek. A paved road through this route would be approximately 29.4 miles long and would be almost entirely located in, or adjacent to, existing stream beds. Although the vertical grades would be less than 2%, the section running through Tommy Smith Creek will be in a narrow, steep-sided canyon which will present hydraulic and road construction problems. The section in Wahweap Creek will be in a canyon bottom also, but one that is not as narrow as Tommy Smith Creek. Generally, the canyon carrying Wahweap Creek has a bottom wide enough for both a slightly elevated, side riprapped road and the Creek. Both canyon bottoms are sparsely vegetated with a few trees, light brush and grasses where stream banks exist. This road would contain 22 stream crossings, and all necessary aggregate would be readily available in Wahweap Creek. The estimated cost for this segment is $10,100,000.

4. Glen Canyon City to Cannonville Road via Wahweap Creek, Tommy Smith Creek and Fourmile Creek. This 28.7 mile segment would be very similar to that found in paragraph B.3. above. The Fourmile Creek Canyon is very narrow just as Tommy Smith Creek Canyon. Just over a mile and a half of 4% grade would be required in Fourmile Creek Canyon. Vegetation and aggregate sources would be generally the same as in B.3. above and would include 26 stream crossings. The estimated cost for this segment is $10,700,000.

5. Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run. A 25.2 mile road with a continuous one and one-half mile 7% grade would be required in this segment. Other than the 7% grade in Smith Run, the general terrain will allow a 4% grade or less. Smith Run Canyon is very similar to Tommy Smith Creek and Fourmile Creek Canyons. However, this road segment will require only 9 stream crossings. Wahweap Creek and Horse Mountain are again the best sources of aggregate. A short section in Nipple Creek contains an exposed shale layer which exhibits very poor road building characteristics. This shale will have to be kept as moisture free as possible and probably will be excavated to a depth such that its swelling characteristics can be controlled. The general terrain is sparsely covered with light brush except for the Fourmile Bench, itself, which contains a light-to-medium concentration of junipers. The estimated cost for this segment is $7,300,000.

6. Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon. This 29.8 mile segment will contain a 7.5% continuous grade of 0.7 mile in Wesses Canyon. The remainder of the vertical alignment will be 4% and less. Wesses Canyon is a very narrow bottomed canyon somewhat similar to Tommy Smith Creek, Fourmile Creek, and Smith Run Canyons. It will be necessary to cross 13 streams on this segment. The geology, vegetation and aggregate situations are very similar to those of paragraph B.5. above. The estimated cost for this segment is $9,300,000.

7. Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon. This segment would be approximately 45.6 miles long and have 43 stream crossings. A maximum grade of 6.8% continuous for 1.4 miles, would be required on this segment. All other grades would be less than 5%. Last Chance Creek and Paradise Canyons are typical steep and narrow canyons very similar to those mentioned earlier. The geology, vegetation and aggregate situations are, again, very similar to B.5. above. The estimated cost for this segment is $16,000,000.

8. Fourmile Bench to Coal Mine via Paradise Canyon and Last Chance Creek. This segment is identical to the northern half of B.7. above and is 21.1 miles in

length. Included is the long 6.8% grade and 22 stream crossings. The estimated cost for this segment is $8,600,000.

9. Nipple Spring to Coal Mine via a portion of Segment B.7. above. This segment is identical to the center third of B.7. above and is 12.9 miles in length. Road grades would be less than 3% and 16 stream crossings would be included. The estimated cost for this segment is $3,700,000.

10. Mouth of Wesses Canyon to Coal Mine. This segment is a part of B.9. above and is 2.4 miles long with 9 stream crossings and no grades steeper than 3%. The estimated cost for this segment is $900,000.

11. Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon. A 41.2 mile road with 8 stream crossings and a 7.5% continuous grade for 0.7 mile in Wesses Canyon plus a 6% continuous grade for 1.5 miles at the top of Missing Canyon. Once again, vegetation is very sparse until Fourmile Bench is reached. An exposed layer of shale is found quite extensively in the section from Glen Canyon City to Warm Creek. This shale exhibits very poor road building characteristics and should be kept moisture free and may have to be excavated to a depth such that its swelling characteristics can be negated. Aggregated sources would be Wahweap Creek and Horse Mountain with small quantities found in Warm Creek. As indicated above, Wesses Canyon is a very narrow bottomed canyon somewhat similar to Tommy Smith Creek, Fourmile Creek and Smith Run Canyons. The estimated cost for this segment is $14,600,000.

Segments B.2., B.3. and B.4. provide access from the Cannonville Road to U.S. 89 near Glen Canyon City, but do not provide direct access to either the mine or the plant sites. Accordingly, the alternatives shown in the Tables beginning on Page 9 do not include these segments. They are included in this Study to show various ways to provide a through north-south route which might be separate and somewhat apart from the plant and mine themselves.

It should be pointed out that the Glen Canyon to Warm Creek section of segment B.11. is common with the primary road alignment proposed in the Glen Canyon City to Bull Frog Basin Study. This Study is scheduled to be presented to the U.S. Congress sometime during October-November, 1974. Utilizing this section for both highway proposals could be a money saving action if acceptable to all parties involved. The National Park Service has expressed some reservation on this course of action as they feel that Congress may direct that the road to Bull Frog Basin be restricted to recreation use only.

Segments B.7. and B.8. appear to go quite a ways out of direction between the coal mine and Fourmile Bench. However, there are other potential coal developers who are working in the area adjacent to Last Chance and Paradise Canyons. These particular segments would appear to provide the best access to these developers should they decide to develop a mine or a plant near their exploratory drilling sites.

C. Nipple Bench Access Roads

Nipple Bench can now be reached by existing jeep trails which allow for fair weather and limited vehicle access only. As a minimum, these jeep trails would have to be leveled and widened to bring them to a condition that will allow construction crews and equipment to get to the plant site. The segments outlined below are to be used in conjunction with the segments outlined in Paragraph B. above. Segments which will provide the added access to reach Nipple Bench are as follows:

1. Nipple Spring to Nipple Bench. This road segment would be approximately 3.9 miles long, with no grades steeper than 4%. Nipple Bench has very little vegetative cover other than scattered small brush. This segment would contain no stream crossings. Aggregate would be brought from Wahweap Creek. The estimated cost for this segment is $800,000.

2. Warm Creek to Nipple Bench via Tibbet Canyon. This segment is 10.3 miles long and contains 5 stream crossings, and has no grades steeper than 3%. This route is only sparsely vegetated with light brush and very few trees. Some aggregate can be found in Warm Creek, but additional will have to be brought from Wahweap Creek. The estimated cost for this segment is $4,700,000.

D. Maintenance and Road User Costs

Estimates of maintenance costs were based on actual maintenance performed on U.S. 89, Kanab to Arizona State Line, and State Route 12, Bryce Canyon to Boulder. Included in the maintenance cost are such items as snow removal, seal coating, lane leveling, stockpiling, paint striping, pot hole patching, litter pick-up, etc. Although maintenance needs should not be too great in the first year or two after construction, the average annual maintenance cost per mile used in this Study only deals with future years which are some years beyond initial construction. For this Study, the annual maintenance cost is approximately $1,300 per mile of roadway.

Road user costs were developed from data supplied by the Weber State College Center for Business and Economic Training and Research as a part of an on-going consultant contract which they have with the Department of Highways. A portion of the information which follows has been extracted from the data provided by this consultant.

Road user costs are those expenses incurred in the operations of a vehicle on a highway. The primary components of user costs are (1) vehicle operating expenses, specifically fuel, oil, tire, maintenance and insurance expenses, and (2) the cost of accidents. The magnitude of operating costs and the incidence and cost of accidents vary in relation to particular highway design characteristics (grades, curves, surface), driving conditions, speeds, types of vehicles, etc. Each of the aforementioned highway design characteristics has a considerable bearing on cost required to operate each different type of vehicle. At this time, the horizontal and vertical alignments plus vehicle mix (cars, heavy truck, buses, etc.) are all subject to considerable change based on future detailed highway design and analysis of expected traffic mix. If all of these factors were known, an operating cost per mile could be computed for each individual alternate. However, based on the limited and preliminary data available at present, a constant figure of $0.0745/mile has been used for this Study. Accident cost data was based on an incident rate of 5.99 accidents per million miles of vehicular traffic on similar type facilities and an average of $1,500 per accident (data derived from 1973 Utah accident statistics). Note also, that the results of this evaluation will be invalidated if a mass transit service is provided for the employees. In determining the vehicle miles on each route, a vehicle occupancy rate of 2 employees/vehicle, with each vehicle completing a daily round trip from the community to a work site was assumed. A bus system would alter significantly the number of daily vehicle miles along each route and thus change the base from which this evaluation was made.

A particular highway can be appraised in terms of user cost by estimating the traffic volume along the route and identifying the associated operating and accident expenses of traveling that route. This approach was used to evaluate the alternate access roads proposed for the Kaiparowits power plant area. The primary use of the access roads will be commuter traffic -- approximately 500 plant operators and 2,100 coal miners will be employed in the area. While there will be some recreation and utility maintenance traffic on the facilities, it is assumed that the volume and distribution of this non-commuter traffic will remain relatively constant regardless of the access road selected.

As indicated above, estimates of road user costs provided in this Study do not include any estimates for traffic other than the internal Kaiparowits commuter traffic. It is interesting to note, however, that a comparison of distances from Glen Canyon City to Cannonville (see Tables II and V) tends to separate the access road alternates into two general groups, i.e., Alternates A and B, or L and M (approximately 60 miles through distance), and Alternates C and D, or N and O (approximately 75 miles through distance). Road user costs for motorists traveling from Glen Canyon City to, and through, Cannonville would tend to favor Alternates A or B (L or M) over C or D (N or O). The mileage difference between Alternates A (L) and B (M) is small enough that it is hard to favor one over the other based on total distance only.

Based on varying assumptions as to the location of the plant, mine, and community, volumes of commuter traffic were calculated for each of the proposed alternates. Applying the accident and operating expense per mile factors to these volumes resulted in estimates of the user costs of traveling along each route. Tables III and VI on Pages 11 and 14, respectively, present a summary and comparison of the annual user costs for each alternative.

One component not incorporated into this evaluation is the time difference involved in traveling the specified routes. Travel time is also very dependent upon items such as vehicle mix, driving speeds, horizontal curves, vertical grades, etc. Another factor subject to wide differences of opinion is the value of a person's time in dollars and cents. It is for these reasons that no consideration has been given to travel time in this Study.

TABLE I. FOURMILE BENCH - AGGREGATE REQUIRED AND CONSTRUCTION COSTS

Route Description	Segments Involved*	Total Mileage	Aggregate (Cu. yds.)	Estimated Road Cost
A. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run plus Nipple Spring to Coal Mine.	B.1., B.5. & B.9.	72.9	874,800	$25,500,000
B. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon plus Wesses Canyon to Coal Mine.	B.1., B.6. & B.10	65.0	780,000	$24,700,000
C. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon.	B.1. & B.7.	80.4	964,800	$30,500,000
D. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon.	B.1. & B.11.	76.0	912,000	$29,100,000

* Refer to corresponding paragraphs in this report with the same sub-heading.

TABLE II. FOURMILE BENCH - COMMUTER DISTANCES (MILES)

Route Description	Segments Involved*	Butler Valley		Clark Bench		Glen Canyon City
		to Plant	to Mine	to Plant	to Mine	to Cannonville
A. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run plus Nipple Spring to Coal Mine.	B.1., B.5. & B.9.	19.2	45.8	25.2	24.4	60.0
B. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon plus Wesses Canyon to Coal Mine.	B.1., B.6. & B.10.	19.2	26.3	32.8	24.4	61.6
C. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon.	B.1. & B.7.	19.2	35.8	50.1	24.4	75.8
D. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon.	B.1. & B.11.	19.2	26.3	45.1	32.0	73.9

* Refer to corresponding paragraphs in this report with the same sub-heading.

TABLE III. FOURMILE BENCH - MAINTENANCE AND ROAD USER COSTS

Route Description	Segments Involved*	Maintenance Cost/Year	Road User Cost/Year	
			Butler Valley	Clark Bench
A. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run plus Nipple Spring to Coal Mine.	B.1., B.5. & B.9.	$ 94,800	$2,208,000	$1,333,000
B. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon plus Wesses Canyon to Coal Mine.	B.1., B.6. & B.10.	$ 84,500	$1,353,000	$1,412,000
C. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon.	B.1. & B.7.	$104,500	$1,770,000	$1,593,000
D. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon.	B.1. & B.11.	$ 98,800	$1,353,000	$1,874,000

* Refer to corresponding paragraphs in this report with the same sub-heading.

TABLE IV. NIPPLE BENCH - AGGREGATE REQUIRED AND CONSTRUCTION COSTS

Route Description	Segments Involved*	Total Mileage	Aggregate (Cu. yds.)	Estimated Road Cost
L. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run plus Nipple Spring to Coal Mine plus Nipple Spring to Nipple Bench.	B.1., B.5., B.9. & C.1.	76.8	921,600	$26,300,000
M. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon plus Wesses Canyon to Coal Mine plus Nipple Spring to Nipple Bench.	B.1., B.6., B.10. & C.1.	68.9	826,800	$25,500,000
N. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon plus Nipple Spring to Nipple Bench.	B.1., B.7. & C.1.	84.3	1,011,600	$31,300,000
O. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon plus Warm Creek to Nipple Bench via Tibbet Canyon.	B.1., B.11. & C.2.	86.3	1,035,600	$33,800,000

* Refer to corresponding paragraphs in this report with the same sub-heading.

TABLE V. NIPPLE BENCH - COMMUTER DISTANCES (MILES)

Route Description	Segments Involved*	Butler Valley		Clark Bench		Glen Canyon City
		to Plant	to Mine	to Plant	to Mine	to Cannonville
L. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run plus Nipple Spring to Coal Mine plus Nipple Spring to Nipple Bench.	B.1., B.5., B.9. & C.1.	36.8	45.8	15.4	24.4	60.0
M. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon plus Wesses Canyon to Coal Mine plus Nipple Spring to Nipple Bench.	B.1., B.6., B.10. & C.1.	38.3	26.3	15.4	24.4	61.6
N. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon plus Nipple Spring to Nipple Bench.	B.1., B.7. & C.1.	52.5	35.8	15.4	24.4	75.8
O. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon plus Warm Creek to Nipple Bench via Tibbet Canyon.	B.1., B.11. & C.2.	51.9	26.3	27.0	32.0	73.9

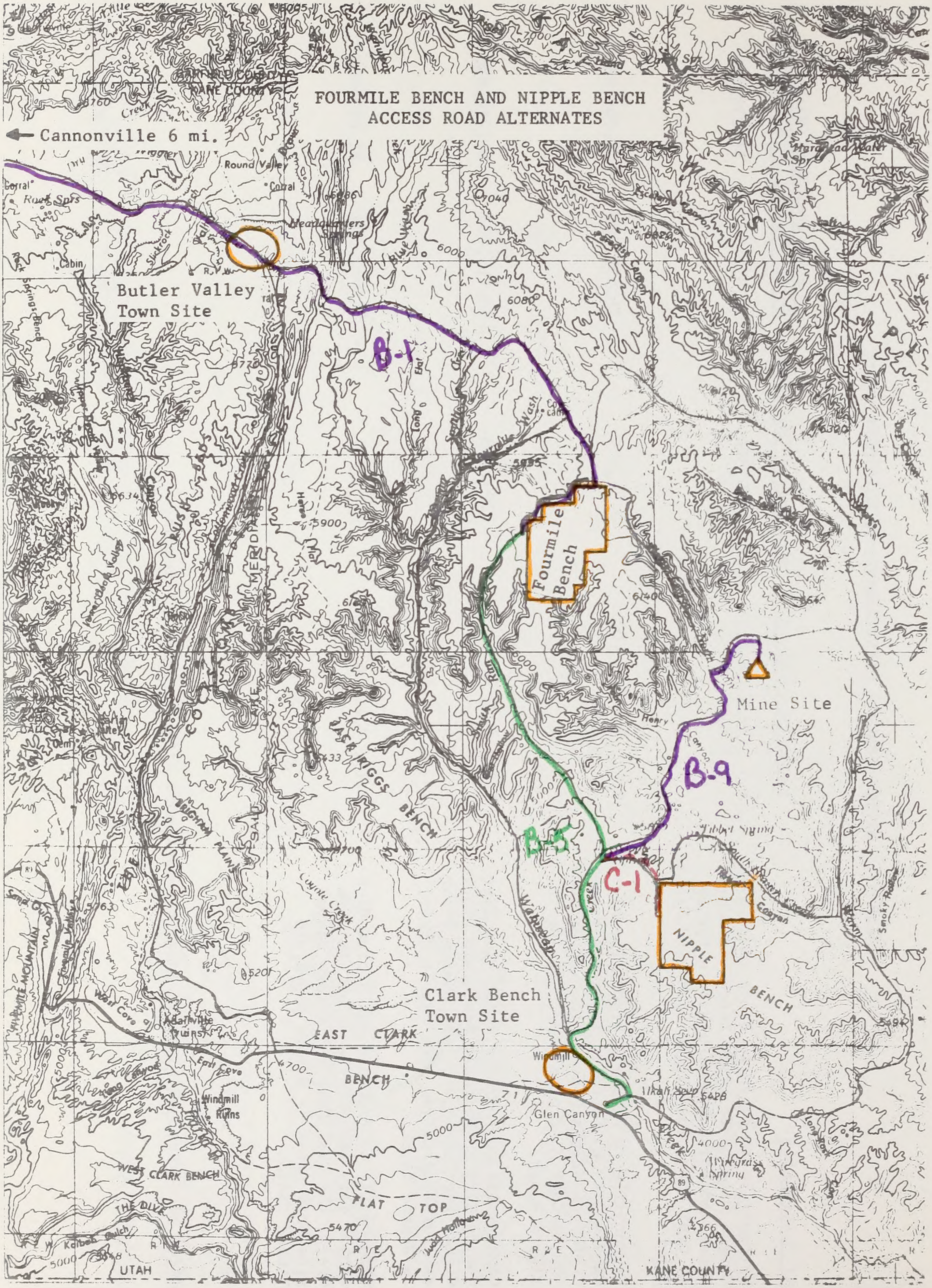
* Refer to corresponding paragraphs in this report with the same sub-heading.

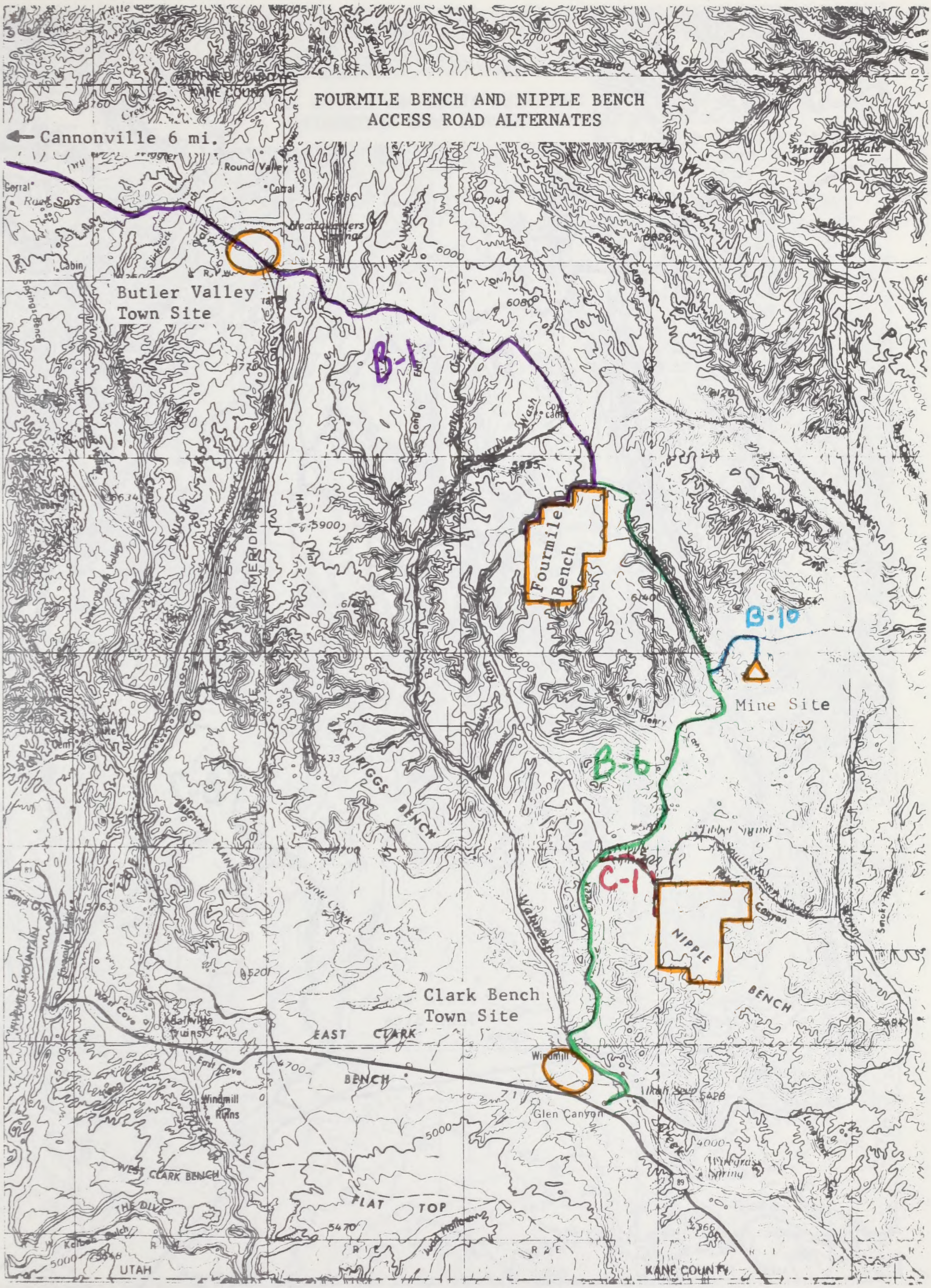
TABLE VI. NIPPLE BENCH - MAINTENANCE AND ROAD USER COSTS

Route Description	Segments Involved*	Maintenance Cost/Year	Road User Cost/Year	
			Butler Valley	Clark Bench
L. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Smith Run plus Nipple Spring to Coal Mine plus Nipple Spring to Nipple Bench.	B.1., B.5., B.9. & C.1.	$ 99,800	$2,392,000	$1,230,000
M. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek and Wesses Canyon plus Wesses Canyon to Coal Mine plus Nipple Spring to Nipple Bench.	B.1., B.6., B.10. & C.1.	$ 89,600	$1,553,000	$1,230,000
N. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Nipple Creek, the Coal Mine, Last Chance Creek and Paradise Canyon plus Nipple Spring to Nipple Bench.	B.1., B.7. & C.1.	$109,600	$2,117,000	$1,230,000
O. Cannonville to Fourmile Bench plus Glen Canyon City to Fourmile Bench via Warm Creek, the Coal Mine and Wesses Canyon plus Warm Creek to Nipple Bench via Tibbet Canyon.	B.1., B.11. & C.2.	$112,200	$1,695,000	$1,685,000

* Refer to corresponding paragraphs in this report with the same sub-heading.

FOURMILE BENCH AND NIPPLE BENCH ACCESS ROAD ALTERNATES





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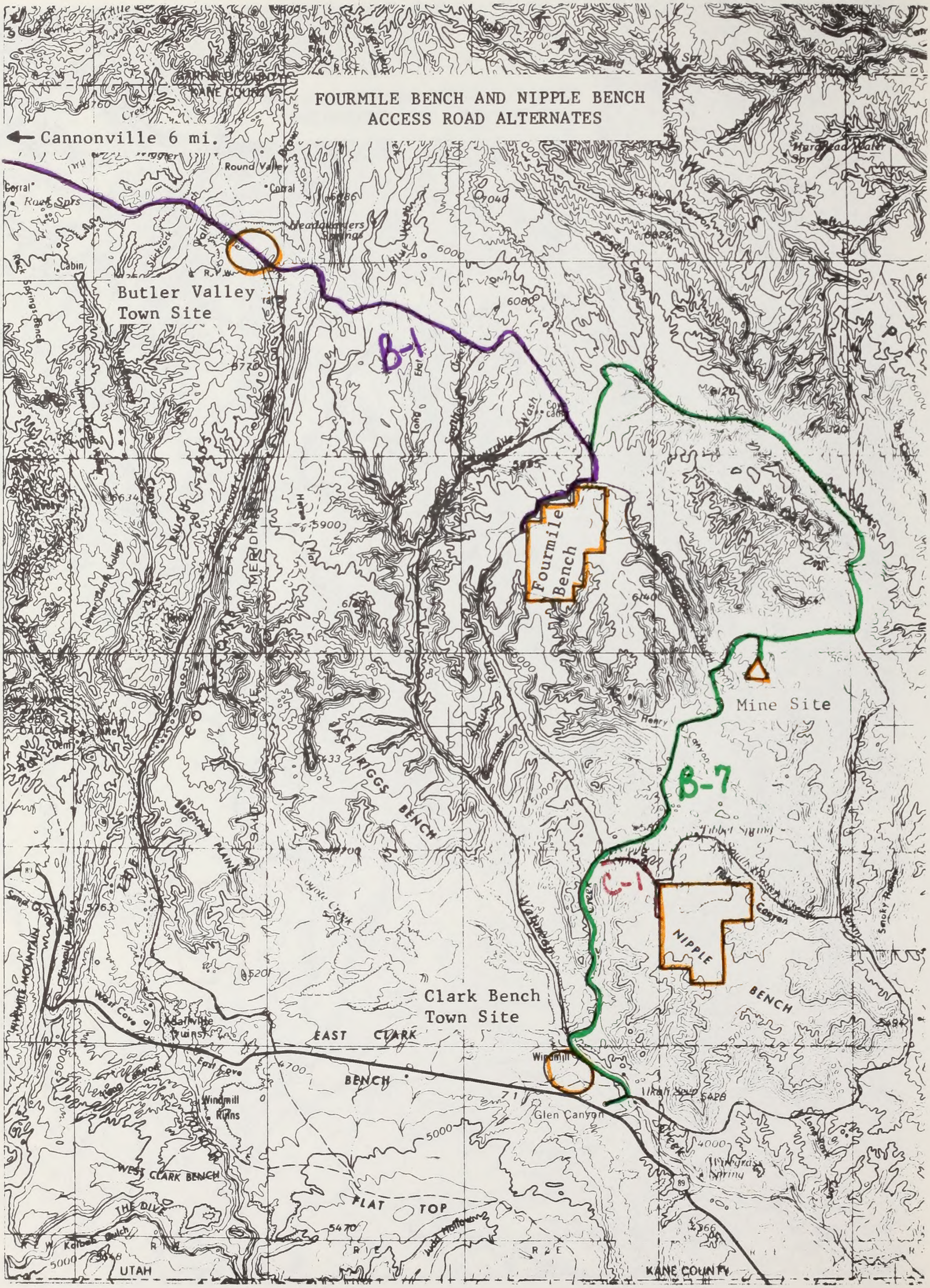
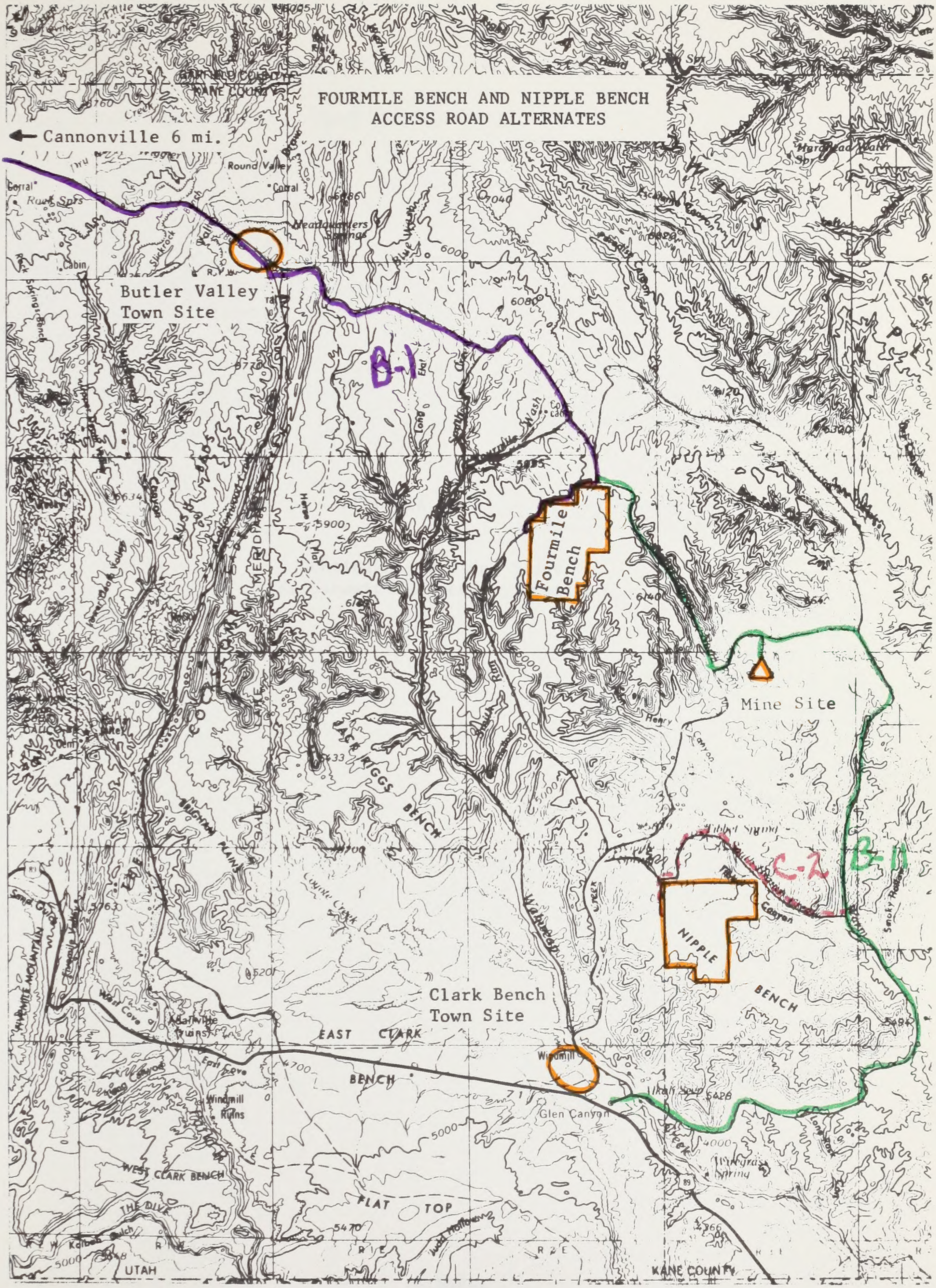

FOURMILE BENCH AND NIPPLE BENCH ACCESS ROAD ALTERNATES



FOURMILE BENCH AND NIPPLE BENCH ACCESS ROAD ALTERNATES
← Cannonville 6 mi.
Butler Valley Town Site
B-1
Fourmile Bench
Mine Site
C-2
B-11
NIPPLE BENCH
Clark Bench Town Site
EAST CLARK BENCH
WEST CLARK BENCH
FLAT TOP
JACK RIGGS BENCH
Round Valley
Headquarters Springs
Glen Canyon
KANE COUNTY
UTAH

APPENDIX I-13

Contingency Housing Plans
Kaiparowits Generating Station

Southern California Edison Company

P. O. BOX 800
2244 WALNUT GROVE AVENUE
ROSEMEAD, CALIFORNIA 91770

March 18, 1975

Mr. Frank Snell
E.I. S. Team Core Leader
Bureau of Land Management
Federal Building Annex
135 S. State St.
Salt Lake City, Utah 84111

Dear Frank:

Subject: Contingency Housing Plans
Kaiparowits Generating Station

In response to your request, we wish to confirm having handed you on December 4, 1974 the Companies' Contingency Housing Plan, copy enclosed. Your current (January) draft of the EIS incorporated our plan and reflects our commitment to provide facilities if required to mitigate service lag in the development of the permanent new community. In light of recent legislation passed by the Utah State Legislature, it seems unlikely that the Contingency Housing Plan will ever be required. For your information, the pertinent bills are described briefly as follows:

Senate Bill 231 UTAH SPECIAL SERVICE DISTRICT ACT

Provides for the formation and operation, as separate entities, special service districts. Provides for the governance and for the powers of these districts, including services to be performed, the levy of taxes and the issuance of bonds.

Senate Bill 256 RESOURCE DEVELOPMENT ACT

Establishes state policy regarding public improvements connected with Development of Natural Resources and with regard to sales or use tax by those engaged in developments involving Natural Resources; provides for the expenditure of these prepayments by the State Road Commission and State Board of Education to finance highway and school construction.

Senate Bill 257 BUILDING SCHOOLHOUSES

Provides procedural requirements for school districts to raise funds for school construction required due to new industrial plants, (bonds, tax levy and applications to Federal Government); allows school districts to enter into contracts (lease-purchase agreements) with developers of industrial plants; restricts issuance of state or local construction permits until Board of Education of the district certifies that funds are/or will be made available to construct minimum school facilities if required.

Passage of the bills has provided a source of "front-money" for highways, schools and other public improvements, thereby enhancing the likelihood that the new community and services will be available when required.

We trust that the above will satisfy your request for a formal commitment by the Companies to the Contingency Housing Plan.

Sincerely,

R S Currie

R. S. Currie
Project Manager
Kaiparowits Power Project

Enclosure

CONTINGENCY HOUSING PLAN

The proposed action for housing of the construction work force incorporates a 400-600 man bachelor camp at the site and the development of the early phases of the permanent new town in a time frame to support the workers coming to the site with family.

Contingency planning has been initiated by the participants in order to be prepared in the event that the permanent new town development does not get underway in a time frame to support the workers with family. At this stage the contingency planning consists of a study done by a consultant in the field of economics, and a preliminary concept proposal by a temporary town developer.

The economic study addresses optimum siting, preliminary estimates of the number of housing units required versus time, and preliminary estimates of the features required (recreational, health, educational, etc.). The temporary town developer used this data to propose a possible concept to meet these needs.

A summary of these two efforts is included below. As permanent new town development plans and activities take form it will become evident whether the contingency planning must be expanded and finalized.

ECONOMIC STUDY

The site selection analysis was performed to determine the optimum location for a temporary community for construction workers in the event the new town development does not begin in time to meet construction worker housing needs. The study considered two potential plant sites; one at Four Mile Bench, located approximately 13 air miles north of Glen Canyon City; one at Nipple Bench, located approximately 7 air miles north of Glen Canyon City.

STUDY APPROACH

In order to ascertain the optimal worker housing site location, reliance was placed upon both primary and secondary research activities. Primary research efforts included:

- o Field inspection and analysis of the Kaiparowits region extending from Glen Canyon National Recreation Area to Kanab, Utah;
- o Interviews with municipal officials regarding provision of services at alternative locations; and
- o Discussions with the new town planning/engineering consultant regarding site development and engineering parameters pertinent to optimal site selection.

Secondary research included, but was not limited to:

- o Analysis of geotechnical data and topographic information gathered from Southern California Edison and various public and private agencies regarding potential worker housing community location; and
- o Analysis of various in house reports prepared by Southern California Edison concerning plant and community location and resultant social and physical problem areas.

SELECTED COMMUNITY SITE AREAS FOR FURTHER INVESTIGATION

Five alternative sites were evaluated as possible locations for the temporary worker housing community. Engineering factors which contributed to this formulation were:

1. A minimum requirement of 600 acres of developable land,
2. Slope not to exceed 10 percent,
3. Physical accessibility to the plant and mining sites,
4. Soils quality deemed physically feasible for community development, and
5. Feasibility of supplying site with water system and utilities.

The five alternate community sites chosen for investigation, oriented to specific generating station locations, were as follows:

Nipple Bench Alternate Plant Site

1. Glen Canyon City - East Clark Bench Community Site - current site of the proposed permanent new town facility, located approximately 7 miles south of Nipple Bench plant site.
2. Nipple Bench Community Site - located approximately 2½ miles south of the Nipple Bench plant site.
3. Nipple Springs Community Site - located approximately 9 miles north of Glen Canyon City.

Four Mile Bench Alternate Plant Site

4. Long Flat Community Site - located approximately 6 to 8 miles to the north-northwest of the Four Mile Bench alternate plant site.

5. Butler Valley Community Site - alternate new town site, located between 12 and 15 miles north-northwest of the Four Mile Bench alternate generating station site.

Physical Factors - The following physical factors were determined to be crucial to successful site development:

1. Slope
2. Soils
3. Climate
4. Natural Vegetation
5. Hydrology - Drainage Potential

Environmental Factors - Two major environmental factors were considered important to the temporary community locational analysis. The first element relates to environmental damage generated by infrastructure recycling. The second consideration is that community development does not cause significant environmental damage to surrounding areas.

Political/Governmental Factors - The primary parameter associated with the public sector was that the temporary community's location will meet with approval from Kane County, Utah.

SITING CONCLUSIONS

On the basis of the locational analysis, the sites considered optimal for temporary community development were determined to be

Numbers 1 and 5, the two alternate new town site alternatives under consideration. The basic findings which support this conclusion were as follows:

- Site Numbers 1 and 5 both provide superior overall access to all potential regional destinations.
- Sites 1 and 5 should both provide excellent amenity value and environmental quality for community residents. Site 1 has excellent amenity potential associated with Lake Powell, while Site 5 is rich in visual quality.
- Housing stock and infrastructure recyclability should be excellent at Sites 1 and 5 since both sites are alternate new town locations.
- The development and recapture costs of infrastructure and housing should be minimal at Sites 1 and 5 since they are alternate new town sites.
- Development costs accruing to Southern California Edison should be minimized at Sites 1 and 5 since the joint location of the new town and temporary community should exhibit economies of scale with respect to construction and disposition expenses.
- The primary physical problem associated with Sites 2, 3, and 4 is poor soil quality. The two alternate new town sites provide a comparatively better soil base

for community development, while the remaining sites would cause several significant engineering-technical problems related to hard rock ground surfaces.

- o The location of both the temporary community and the permanent new town at the same site minimizes potential environmental damage exposure since only one location faces potential damage.
- o Kane County taxpayer liability is minimized at Sites 1 and 5 because public services may be financed out of permanent new town assessed valuation, rather than low-value temporary and mobile oriented development.

In summary, it is concluded that a temporary community development should be sited at the location of the new town (Site 1 or Site 5), if a new town development is not undertaken in a time frame to support construction workers with families.

HOUSING UNITS (QUANTITY)

Based on both project construction and secondary employment-related population, it is projected that the range of required housing units for the temporary construction community will increase according to the following schedule. The data presented are current projections and subject to revision as more finite information is developed.

- By the third year of project development, plant construction employment will increase significantly. In addition, competing housing projects in the surrounding vicinity will be reaching maximum capacity, thus leading to the significantly increased project capture rates.

COMMUNITY FEATURES

Community features which will be included in the temporary worker housing complex are:

- Community recreation center including tennis courts, swimming pool, field sports areas and community building for town meetings and special events,
- Community park for picnics and social events,
- Children's center, including day care facilities for working wives,
- Storage areas for boats and recreation vehicles.

Temporary community housing unit features will include the following:

- If mobile home units are utilized, a complete package should offer furniture and major appliances,
- Paved driveway and storage space for second car or small recreation vehicle,
- Carpets and drapes,
- Covered balcony or patios,
- Air conditioning,
- Cable television hook-ups,
- Orientation to view potentials. and
- Individual unit fencing

GOVERNMENTAL ELEMENT

The temporary community must provide equal or even greater public services than are provided for residents of existing communities in the area if it is to capture a significant amount of construction housing demand. Specific services which should be provided at the temporary community are as follows:

1. Education
    - a) Junior High School and High School in one facility, grades 7-12,
    - b) Elementary School, grades 1-6
2. Police Protection - Full time patrol
3. Fire Protection - Located within town boundaries or in close proximity
4. Post Office
5. Local Parks - Component of new town plan
6. Health Services - Small hospital and out-patient clinic
7. Library - Portable bookmobile for interim construction period with permanent facility part of school development program
8. Pest Control
9. Refuse Collection and Disposal.

It is anticipated that coordination among the applicant, the developers, state and Kane County officials would be necessary to carefully determine levels of service.

CONCEPT PLAN FOR CONSTRUCTION HOUSING

A temporary community for field construction personnel could be developed in stages at a site having reasonable access to the construction site. Necessary support facilities would be provided in the community.

The plan outlines an approach to providing housing based upon specific objectives and assumptions, and includes a Concept Plan which is phased to meet the projected housing needs for construction workers. It is presumed that this community can be built at the site of the proposed New Town and that parts of the temporary town can be adapted to become a permanent part of that proposed community.

OBJECTIVES

The Contingency Plan is based upon two primary objectives: 1) to provide convenient housing for construction workers in the event that housing is not yet available from the proposed New Town; and 2) to develop the community at sufficiently high standards and with adequate amenities to not only attract qualified construction personnel, but also to reduce the turnover rate for employees to the greatest extent possible.

The provision of housing for construction workers within commuting range of the Kaiparowits construction site is an unavoidable preliminary to construction. There are few available workers within commuting range of the Kaiparowits site and virtually no housing available for new workers. In providing housing, an additional opportunity is open--namely, designing the housing so that it in itself becomes an inducement and attraction to workers.

ASSUMPTIONS

In developing the Concept Plan, it has been assumed that the construction community would be built at the site of the proposed permanent New Town. This anticipates that a decision will have been made as to the specific location of the New Town site. This assumption has been made primarily because of the overwhelming logic that supports the installation of utilities, roads, and other infrastructure, and schools, shopping, recreation and other community facilities which are permanent or which can be re-used as a part of the New Town. The high cost of providing such utilities and facilities cannot be easily justified unless there is a long and permanent application for them. Moreover, the essential objectives of attracting and retaining workers require that these facilities be of reasonably high standards, and the higher costs of obtaining quality in the community can be better justified if the improvements are permanent.

It is assumed that the permanent New Town would be under active development within four years of the start of construction of the generating facility. The construction community is therefore phased over three years as Contingency Plan which would adequately cover the longest probable period of delay.

It was also assumed that the site is reasonably level and that no unusual problems of providing utilities would be encountered. It is assumed that a package treatment plant would be provided off the site and that sewers, water lines, and other utilities would be sized so as to become a permanent part of the community. Community facilities such as schools, fire station, recreational facilities and the like are assumed to be a needed part of this community, but no assumptions have been made at this time as to the governmental agencies required to administer and operate these facilities. It is assumed that the implementation program for the permanent New Town will address this problem and that those recommendations can be adapted to the operation of any facilities that are provided.

It is also assumed that a highway will be extended through the New Town site, and that this highway would be the principal traffic artery for the New Community.

APPROACH

Before developing a Concept Plan, it was necessary to anticipate the generalized form that the permanent New Town would have. A sketch of this anticipated form is shown on the attached plate. It assumes that a large core area would be surrounded by principal traffic arteries and would contain in a centralized area the business district, municipal facilities, and the institutional (educational, cultural, recreational, and religious) facilities for the entire community. Surrounding this core are residential neighborhoods. The number and size of neighborhoods is a function in part of the project growth of the community, and in part of the long term growth prospects of the New Town. The sketch shows six residential neighborhoods and an area for future industrial development. While no effort has been made to qualify the specific needs of the future New Town, the sketch anticipates that approximately 2,000 acres would be devoted to residential area, with about 500 acres devoted to the Town Center, and an indeterminate amount reserved for future industrial growth.

The circulation system is based upon the main highway which will become a loop around the Town Center. The highway separates the residential neighborhoods from the Town Center, and collector roads branch off of this to provide principal access into and through the residential communities. Housing is clustered on loop roads or cul-de-sacs which branch off the collector roads. Secondary connections between neighborhoods are provided, but are intended only for low intensity traffic to give convenient access to the elementary school playground facilities and between neighborhoods.

Residential Development

Two categories of dwelling units are proposed for the site--mobile homes and modular homes. The mobile homes occupy neighborhood clusters identified by the letters A through G on the Concept Plan. The modular homes occupy those neighborhood clusters identified by the letters H through L on the Concept Plan.

The mobile home lots have an average size of 50 x 150 feet, and the units are clustered so as to provide convenient access to recreational facilities. These lots can be easily modified after completion of the construction phase to use for permanent dwellings by combining two lots into one.

The modular homes are located on larger lots in separate neighborhoods. The lots for the modular homes average 65 feet in width by 175 feet in depth. These lots are intended to be permanent lots, and ample space is allocated so as to allow for room and privacy for each family. Individual lots for both categories of housing are located on cul-de-sacs or loop streets which branch off a collector road. Since no driveways have direct access onto the collector road, the road can function with greater safety and less traffic conflict as an arterial serving the neighborhood.

The Concept Plan proposes a similar layout of cul-de-sacs and roads. The smaller neighborhoods which result should facilitate social interchange among the new and transient members of the community and should facilitate traffic safety in the neighborhoods. The individual neighborhood clusters are separated by open space which can be utilized as pedestrian ways providing walking and bicycling paths which are generally independent of the vehicular road system. The pedestrian paths lead to larger open spaces which are utilized for parks and playground facilities.

Educational System

The rapid growth of population will require the installation of an educational system and at as early a time as possible. The Concept Plan anticipates that a school would first be built between the two residential neighborhoods which will become an elementary school, but would serve originally as the sole educational facility serving the community. Until this first school is built, students could be bused to existing schools within the region.

The Concept Plan calls for an expansion of the school facilities in the Town Center area to accommodate a secondary educational program. Such facilities must obviously be carefully interrelated to the plans for the permanent New Town. It is assumed by the Concept Plan that a central educational facility can be developed in accordance with its own Master Plan to ultimately provide for a middle school, a high school, and specialized facilities such as a gymnasium, auditorium, cafeteria and the like. The growth of the population in the construction community as shown on the Concept Plan would require that the secondary school be constructed during the third year in order to accommodate the large number of children and in order to provide more specialized educational facilities. Space for the athletic facilities for the secondary educational facility would be located adjacent to that facility in the Town Center.

Recreation

Through the three years anticipated by the Concept Plan, four playgrounds and a recreational center would be provided. The playgrounds are relatively small and located adjacent to the residential neighborhoods. The largest of these would be located adjacent to the elementary school and would provide recreational facilities and playground facilities for the students as well as for the residents of the neighborhood.

The recreational center is proposed for early construction in the Town Center. It will have a community building, a swimming pool , and other appropriate recreational facilities. The community building would constitute the social center of the neophyte community and, as such, has an extremely high priority. Social functions should be programmed to maximize opportunities for leisure time activities for the residents. This is particularly important in this remote location during the early stages of the community's development. The building could also serve on an interim basis for religious services, and as a day-care center. (The shortage of workers in this new community will place a premium on working wives.)

Commercial

Commercial facilities should be expected to expand proportionately to the population, since the distance to alternative shopping facilities is substantial. The Concept Plan anticipates that a future shopping center would be developed in the Town Center, and that portions of this can be installed at an early phase in order to provide convenient shopping for the residents. It is anticipated that this could be accommodated through the construction of a universal space structure which can be subdivided to accommodate interim shopping needs, and re-subdivided later to respond to changing markets and changing commercial needs. A prefabricated structure of durable construction is proposed for this facility.

A motel is also proposed near the shopping center to accommodate new arrivals, itinerants, and housing overloads which may occur from time to time. A restaurant would also be provided at the motel site.

Health

A small clinic is proposed in connection with the municipal building to accommodate health services. It is anticipated that health services would be provided primarily by a nurse or para-medic team until the population reaches a point where it can support a doctor and attendant medical facilities. Emergency access to some hospital in a nearby community should be provided.

Safety

The municipal building would also provide facilities for fire protection and for policing the community. Management of the community would also require space at the municipal building. A durable, high quality, pre-fabricated building may serve as the municipal building during the early stages.

PHASING

Phasing of the construction community is shown on plate ____. It anticipates a three-year construction period predicated on the assumption that the permanent community may not be developed in time to meet the housing requirements for construction workers, but that in no case will it be delayed more than three years from the start of the construction of the Kaiparowits Project. The numbers of units are based roughly on the projected requirements for housing as indicated in the economic report. The actual number of units which are provided vary somewhat from the above cited report, but detailed scheduling and adjustment of the Plan can accommodate a number of variables which may arise.

First Year

The first year calls for the construction of a 100-unit motel near the main entrance of the community which will accommodate construction workers at the site and will provide housing for newly-arrived and itinerant workers.

Two housing clusters would be completed within the first year--those labeled A and H. Cluster A would accommodate 35 mobile homes, Cluster H 35 modular homes. A playground, which eventually would become a playground serving the elementary school, would be begun during the first year to provide recreational facilities for the first residents. In addition, the sewage treatment plant to serve the projected development would be constructed off the site.

Second Year

During the second year, 565 mobile homes would be installed and 325 modular homes. A 16-classroom elementary school would be constructed and would serve initially as the central educational facility for the entire community, housing all grades under one roof. The recreational center would be constructed during this year and would provide the community building, swimming pool, and areas for court games. The municipal building would be started during the second year to provide fire protection and a clinic. The first phase of a future shopping center would also be completed to provide approximately 12,000 square feet of shopping area to accommodate needs of the residents. Altogether, 890 dwelling units would be installed during the second year, bringing the total number of units available to 960, not counting the 100-room motel.

Third Year

During the third year, 640 mobile home units and 425 modular units would be constructed. These 1,065 units would bring the total units available to 2,025. In addition, two playgrounds would be installed, the secondary school complex would be initiated, a library would be added to the municipal building and the clinic would be expanded. These facilities should, of course, dovetail into the planning and programming of the permanent town.

SUMMARY

The Concept Plan provides for a phased development of housing for construction workers over a satisfactory period of time to assure that the permanent New Town can be underway to meet subsequent housing needs. The Contingency Plan anticipates a delay of up to three years between the start of construction of the Kaiparowits project and the actual development of the permanent new community. It allows for the construction of more than 2,000 housing units in a framework that can be adjusted both upward or downward to accommodate any variation in the projected housing requirements.

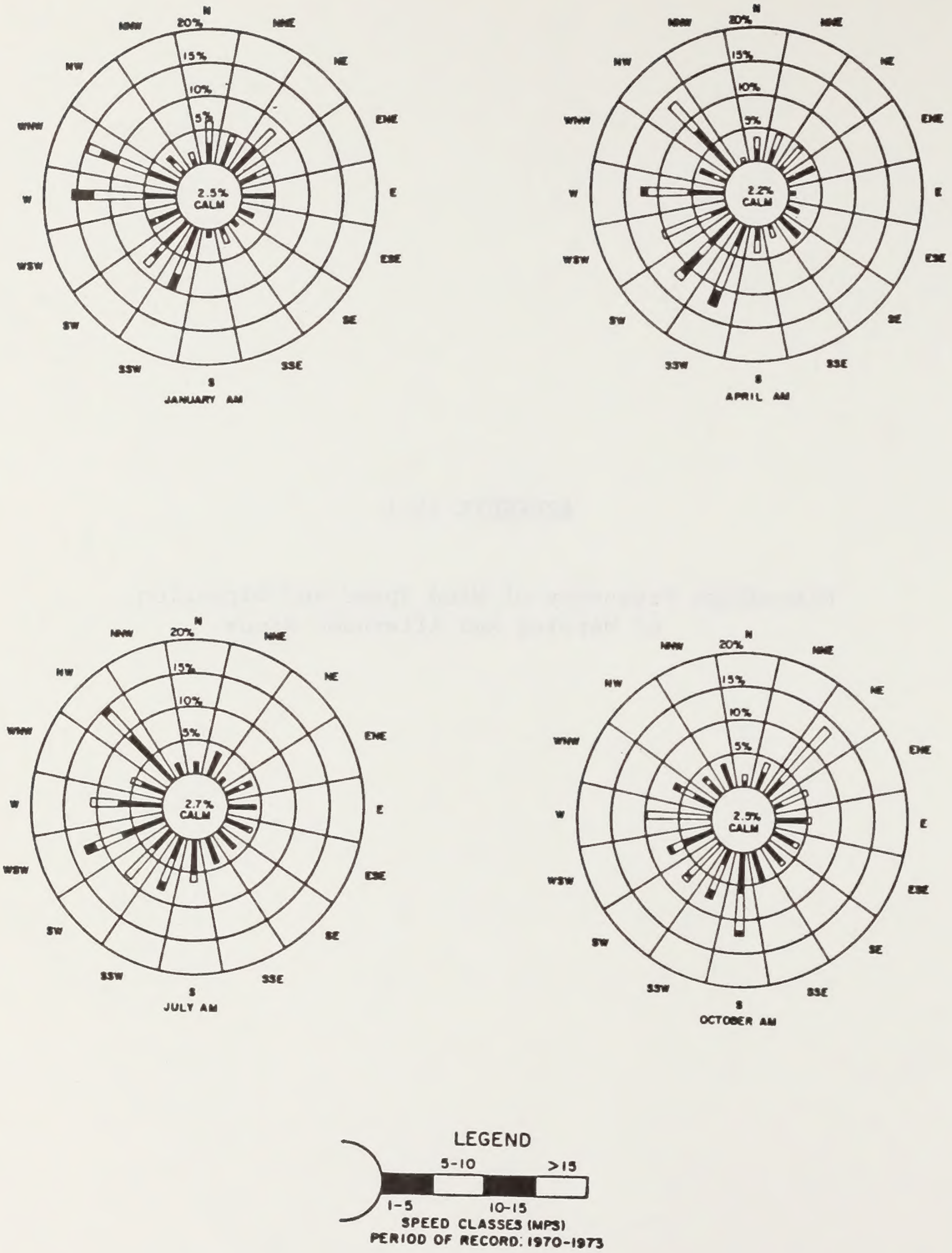
The Concept Plan is adaptable to various forms that may be developed for the permanent New Town, and will be developed so that it can become a permanent part of the new community. The mobile home units may remain as a mobile home park if the need for such a facility is evident, or the mobile home units may be removed and every two mobile home lots would then become one permanent lot in the permanent community.

An adequate level of community support facilities is projected by the Contingency Plan to meet the needs of the construction workers, and these facilities can be adapted to permanent use within the new community. The streets and circulation system are designed to function not only on the interim level, but also to provide permanent traffic facilities for the new town and to accommodate growth through the future of that town.

The Economic Study and the Concept Plan are preliminary. They form a contingency plan assuming that the permanent New Town development does not proceed in a time frame to support the construction work force buildup. As the permanent New Town development plans take form it will become evident whether the contingency planning must be expanded and finalized.

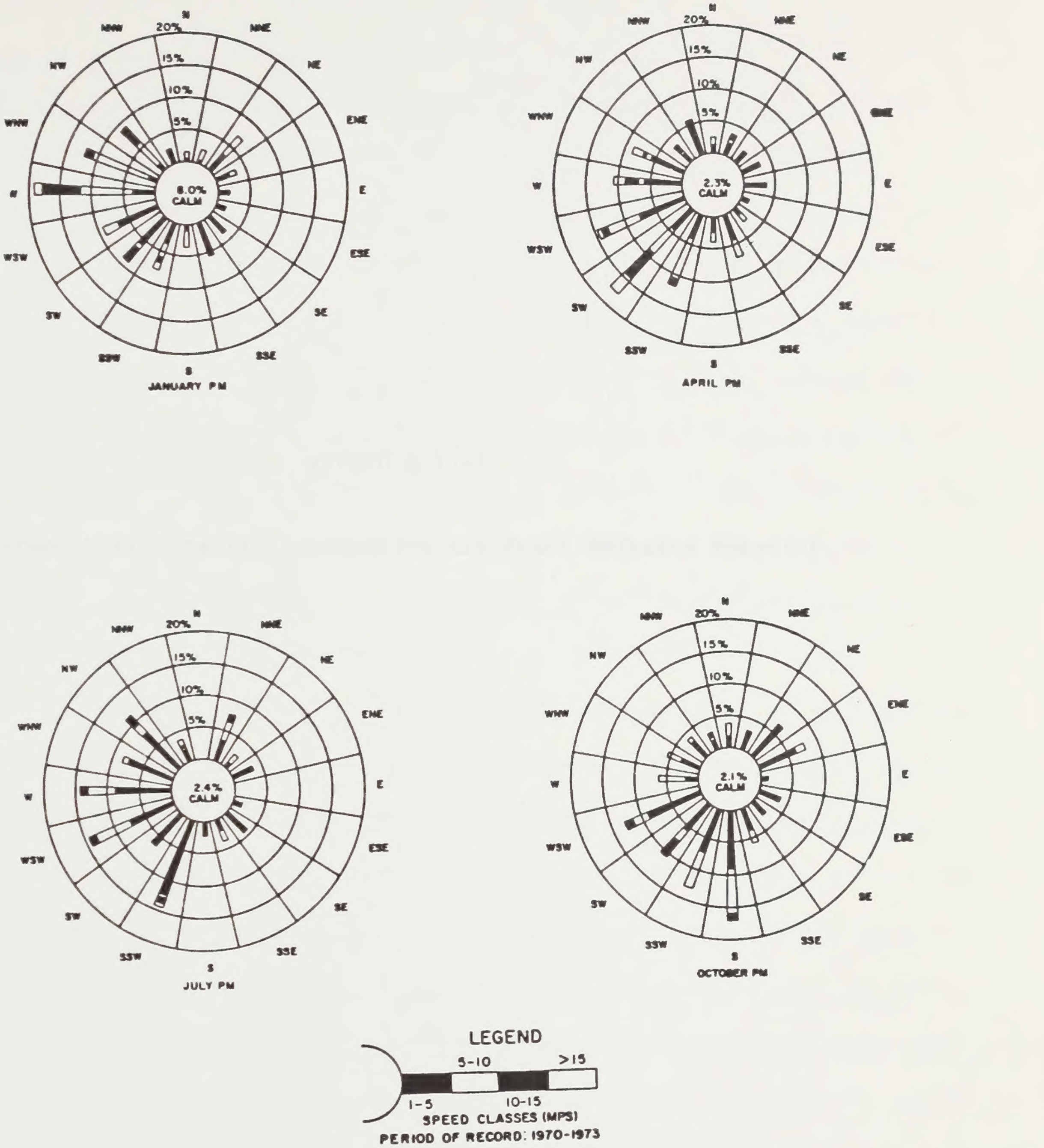
APPENDIX II-1

Percentage Frequency of Wind Speed and Direction of Morning and Afternoon Winds



Percentage frequency of wind speed and direction of morning winds at 7,300 feet MSL over Page, Arizona. Data taken from Dames and Moore 1973.

ILLUSTRATION I



Percentage frequency of wind speed and direction of afternoon winds at 7,300 feet MSL over Page, Arizona. Data taken from Dames and Moore 1973.

ILLUSTRATION 2

APPENDIX II-2

Atmospheric Stability Structure and Stack Emission Behavior

APPENDIX II-2

Air Quality

Atmospheric stability structure and stack emission behavior

Changes in air temperature with height define the stability of the atmosphere (whether vertical air motions are subdued or amplified). If the air temperature increases with height (termed a temperature inversion), or if it decreases less than the adiabatic lapse rate (defined as a temperature decrease of 1^{o} centigrade per 100 meters), the atmosphere is stable and plume rise and dispersion of emissions is restricted. Stable conditions generally occur with clear skies and light winds at night as a result of radiational cooling. Nighttime conditions are usually characterized by formation of a low-level temperature inversion layer from nocturnal cooling of the earth's surface. The base of the stable layer can be at ground level or at varying elevations above ground. Daytime conditions are characterized by air temperature decreasing with height because of ground-surface heating. During cloudy, windy day or windy night conditions the temperature lapse rate is nearly adiabatic, and the atmosphere is defined as neutrally stable. On a clear summer day, rapid heating of the earth can warm the air near the surface to where the decrease in air temperature with height is greater than the normal adiabatic lapse rate, (superadiabatic). Under these conditions the atmosphere is defined as unstable; marked vertical mixing of air results, and pollutants are dispersed rapidly.

The shape or configuration of a stack plume is largely dependent upon temperature and wind structure influencing the plume. Of primary importance in determining plume behavior, and consequently its effect at ground level, are the relative heights of the stack plume and the base of an influencing stable air layer. Illustration 1 provides an idealized representation of plume behavior under stable, neutral, and unstable atmospheric conditions as well as inversion breakup and limited mixing conditions.

Briggs (1969) has identified and described the typical behavior of smoke plumes associated with diurnal heating effects.

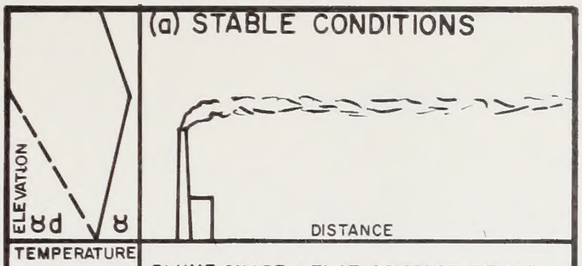
An inversion is formed on clear nights when the ground radiates heat and surface air is cooled. This stable layer may be one or two thousand meters deep, so plumes rising through it rapidly reach equivalent buoyancy level. This is the fanning type plume characteristic of clear skies and light winds at night or in early morning.

After sunrise the ground warms and temperature increase associated with height then changes to a decrease with height to remove the surface inversion (burnoff). Convective eddies develop and penetrate higher as daytime ground heating progresses. When the eddies reach the height of the plume, they rapidly mix the plume toward the ground while the inversion aloft prevents upward diffusion. This inversion breakup condition, called fumigation, can bring relatively large concentrations of effluent to ground level.

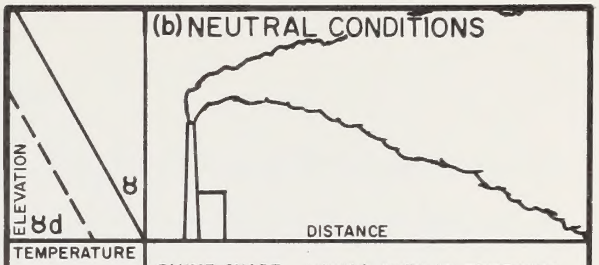
After an inversion has been destroyed by convection, or during cloudy and windy days or windy nights, the atmosphere is well mixed and has essentially neutral stability. Plumes then rise and diffuse in a smooth fashion known as coning.

Later in the day when heating at the ground intensifies, the lapse rate becomes unstable and large convective eddies form to twist and fragment the plume in a manner described as looping. Short periods of relatively high concentrations are experienced whenever the looping plume reaches the ground.

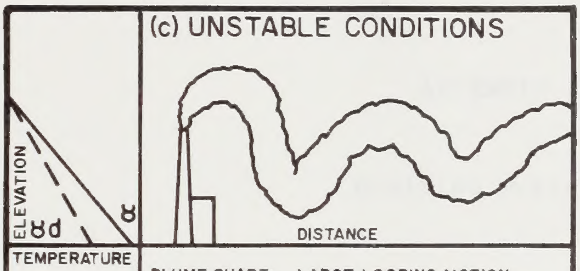
Near sunset, convection diminishes and a ground-based radiation inversion begins to form again. The plume can penetrate this weak inversion, but cannot diffuse downward because of the underlying stable conditions. This condition called lofting, is the most ideal for releasing effluents since the effluents are least likely to reach the ground. The limited mixing condition consists of an elevated inversion with a neutral or well mixed layer below. The inversion generally acts as a lid to effectively reduce vertical dispersion of emissions. The emissions are trapped within the mixing volume as determined by height of the inversion base and surrounding terrain.



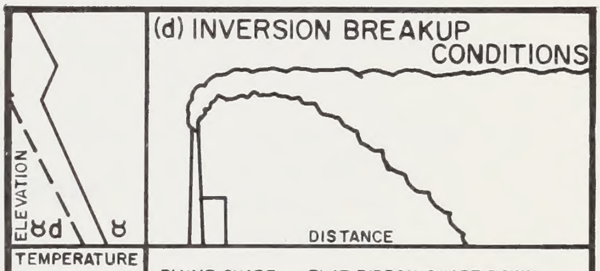
PLUME SHAPE :	FLAT COMPACT RIBBON.
WIND SPEED:	USUALLY LESS THAN 4 M.P.S.
CONDITIONS:	CLEAR SKIES WITH LIGHT WINDS AT NIGHT.
DISPERSION:	MINIMAL DISPERSION VERTICAL DIRECTION, SOME HORIZONTAL SPREADING AND MEANDERING.



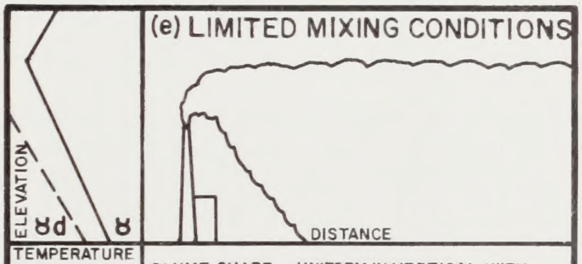
PLUME SHAPE:	CONICAL WITH AN EXTENDED HORIZONTAL AXIS.
WIND SPEED:	ALL.
CONDITIONS:	CLOUDY AND WINDY DAYS OR WINDY NIGHTS.
DISPERSION:	RAPID DISPERSION IN BOTH HORIZONTAL AND VERTICAL DIRECTION.



PLUME SHAPE:	LARGE LOOPING MOTION
WIND SPEED:	USUALLY LESS THAN 4 M.P.S.
CONDITIONS:	STRONG DAYTIME SOLAR HEATING WITH LIGHT VARIABLE WINDS
DISPERSION:	EXTREMELY RAPID VERTICAL DISPERSION AND RAPID HORIZONTAL DISPERSION



PLUME SHAPE:	FLAT RIBBON SHAPE DOWN WIND TO MIXING DISTANCE, FOLLOWED BY A UNIFORM SHAPE
WIND SPEED:	USUALLY LESS THAN 4 M.P.S.
CONDITIONS:	TRANSITION FROM NIGHT TIME STABLE FLOW TO MORNING NEUTRAL OR UNSTABLE FLOW PLUME INITIALLY EMBEDDED IN STABLE LAYER IS RAPIDLY MIXED TO THE GROUND AS A MORNING MIXING LAYER BUILDS UP TO PLUME ALTITUDE.
DISPERSION:	MINIMAL PRIOR TO PLUME BREAKUP THEN EXTREMELY RAPID



PLUME SHAPE:	UNIFORM IN VERTICAL WITH LATERAL SPREADING
WIND SPEED:	USUALLY LESS THAN 6 M.P.S.
CONDITIONS:	ELEVATED SUBSIDENCE INVERSION ASSOCIATED WITH A LARGE HIGH PRESSURE WEATHER SYSTEM SERVES AS AN EFFECTIVE LID ON THE VERTICAL DISPERSION OF EMISSIONS.
DISPERSION:	UNIFORM IN VERTICAL WITH LATERAL SPREADING.

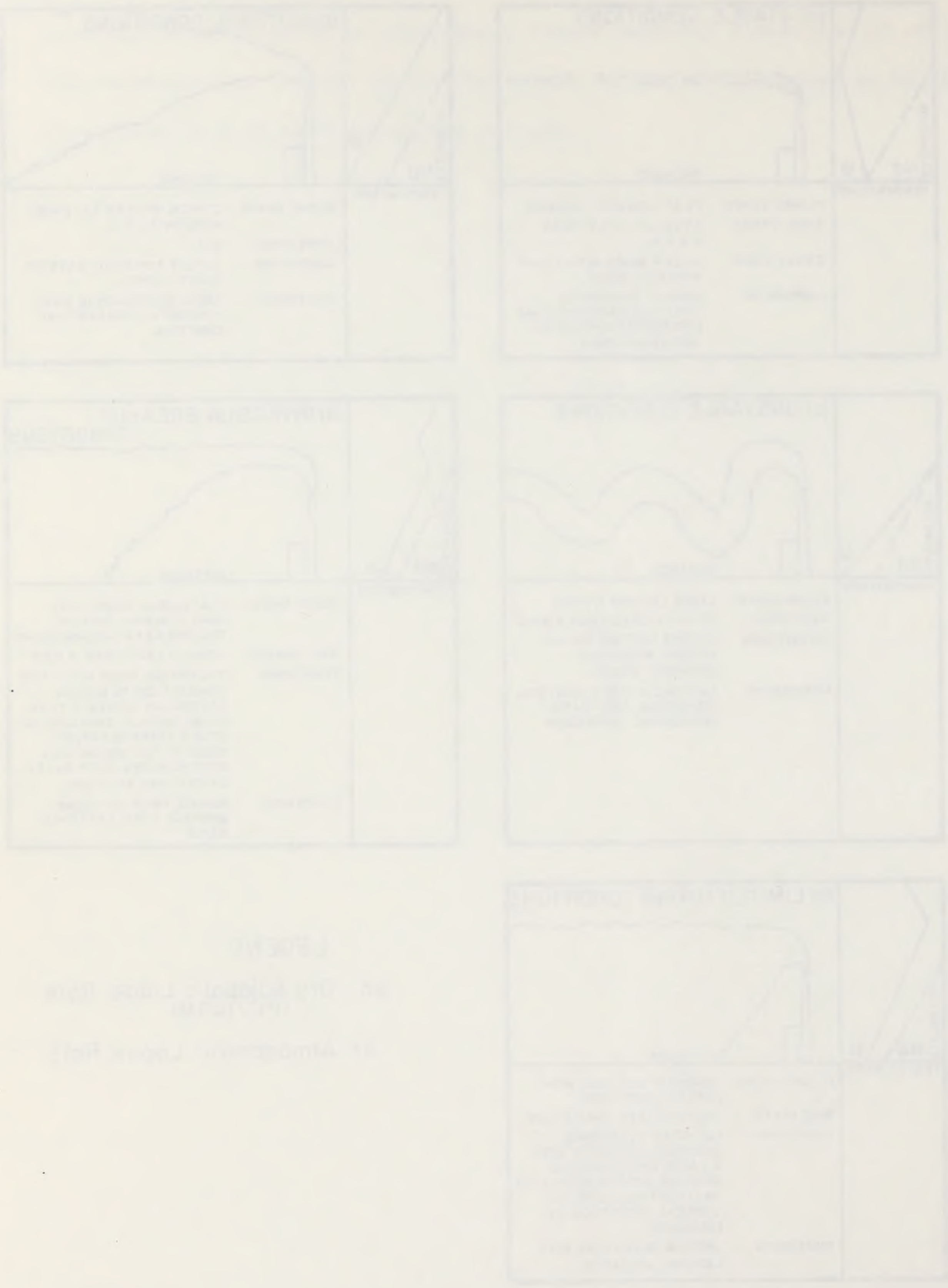
LEGEND

ɣd = Dry Adiabatic Lapse Rate (1°C/100M)

ɣ = Atmospheric Lapse Rate

IDEALIZED DISPERSION PATTERNS FROM A TALL STACK UNDER VARYING ATMOSPHERIC CONDITIONS.

ILLUSTRATION I



IDEALIZED DISPERSION PATTERNS FROM A TALL STACK UNDER VARYING ATMOSPHERIC CONDITIONS

ILLUSTRATION 1

APPENDIX II-3

Modified Mercalli Scale

APPENDIX II-3

Geology and Topography

Generating Station and Mine Impact Area

Modified Mercalli Intensity Scale of 1931 (Abridged)

I. Not felt except by a very few under especially favorable circumstances. (I Rossi-Forel Scale,)

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (I to III Rossi-Forel Scale.)

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing truck. Duration estimted. (III Rossi-Forel Scale.)

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes windows, and doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (IV to V Rossi-Forel Scale.)

V. Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plater; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel Scale.)

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel Scale.)

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken. Noticed by persons driving motorcars. (VIII - Rossi-Forel Scale.)

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX + Rossi-Forel Scale.)

X. Some well-built wooden structures destroyed; mostly masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel Scale.)

XI. Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

APPENDIX II-4

Soil Interpretations Data

APPENDIX II-4

Soils

Kaiparowits Plateau impact area

Soils interpretation data

Methodology for soils interpretations

1. Soils data developed from watershed inventories and soil association information are presented in Illustration 1 this section.

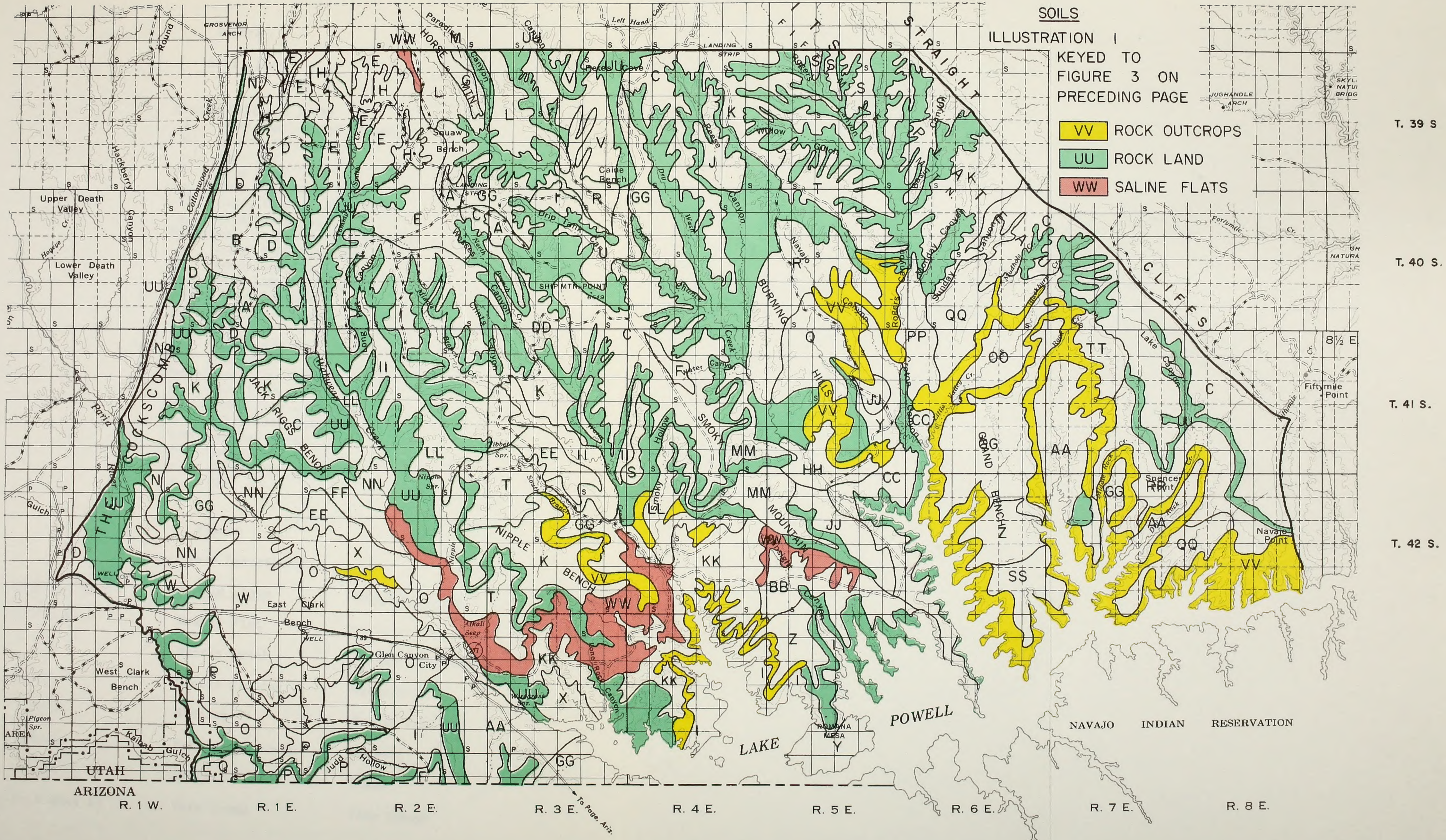
2. Existing erosion conditions were determined by evaluating soil movement, surface litter, surface rock, pedestalling of plants and surface rock, flow patterns on the soil surface and the magnitude and frequency of rills and gullies.

3. Effective root depth (ERD) is the depth of soil material which supports most plant growth. This depth is obtained by measuring from the soil surface to a limiting layer or where the abundance of roots changes from many to few.

4. Soil texture is determined from samples taken between a depth of one-quarter to four inches, and between four inches and the effective root depth. Soil texture is divided into five broad categories: coarse textured, moderately coarse textured, medium textured, moderately fine textured. Figure 1 lists the soil classes within each broad texture category and the appropriate Soil Conservation Service symbol.

5. Slope is presented in percent and represents the whole area. Slope was one of the prime criteria used for making engineering interpretations. Figure 2 delineated the slope classes and standard descriptions.

6. Estimated sediment yield was obtained by considering surface geology, soils, storm frequency and intensity, runoff, topography, ground cover, past and present land use, upland erosion, channel erosion and sediment transport. The procedure used had been developed by the Pacific Southwest Interagency Committee (Shown, 1970).



SOILS

ILLUSTRATION I
KEYED TO
FIGURE 3 ON
PRECEDING PAGE

VV	ROCK OUTCROPS
UU	ROCK LAND
WW	SALINE FLATS

Figure 1

Soil Class

1. Coarse Textured Soils
    a. Very Coarse Sand (vcos)
    b. Coarse Sand (cos)
    c. Sand (s)
    d. Fine Sand (fs)
    e. Very Fine Sand (vfs)
    f. Loamy Coarse Sand (lcos)
    g. Loamy Sand (ls)
2. Moderately Coarse Textured Soils
    a. Loamy Fine Sand (lfs)
    b. Sandy Loam (sl)
    c. Fine Sandy Loam (fsl)
3. Medium Textured Soils
    a. Very Fine Sandy Loam (vfsl)
    b. Loam (l)
    c. Silt Loam (sil)
    d. Silt (si)
4. Moderately Fine Textured Soils
    a. Clay Loam (cl)
    b. Sandy Clay Loam (scl)
    c. Silty Clay Loam (sicl)
5. Fine Textured Soils
    a. Sandy Clay (sc)
    b. Silty Clay (sic)
    c. Clay (c)

Figure 2

Slope Class Descriptions

Percent Slope	Simple Slope	Complex Slopes
Less than 1	Nearly Flat	----------------
1-3	Nearly Level	Gently Undulating
3-8	Gently Sloping	Undulating
8-15	Sloping	Gently Rolling
15-30	Moderately Steep	Rolling
30-45	Steep	Steep
Greater than 45	Very Steep	Very Steep

7. The percent probability of success for reseeding was developed by adapting watershed inventory data and known soils data to the soil suitability guide designed by the Bureau of Land Management (Hagihara, et al, 1972).

8. The erosion susceptibility formula was developed by considering slope, parent and bed material, and soil texture. Slight erosion susceptibility pertains to slopes less than 15 percent, comprised of consolidated material such as igneous or crystalline rock and a soil texture generally coarse to moderately coarse. Moderate erosion susceptibility pertains to slopes between 15 to 30 percent, comprised of alluvium or unconsolidated material and generally medium soil texture. Severe erosion susceptibility pertains to slopes in excess of 30 percent and soil textures generally moderately fine to fine.

9. The hydrologic soil group is based on soil depth and infiltration rates in inches per hour. Generally, hydrologic group A has an infiltration rate in excess of 3.5 inches per hour; hydrologic group B, 2.0 to 3.5 inches per hour; hydrologic group C, 0.5 to 2.0 inches per hour, and hydrologic group D, less than 0.5 of an inch per hour.

Discussion of soils limitation ratings

All soil limitation ratings presented in Figure 3 are based on criteria developed by the Soil Conservation Service (SCS, 1971). The information is not intended to be specific enough for detailed design of engineering installations but is specific enough to make a general evaluation of limitation or suitability for selected uses.

Soil limitation ratings are expressed in three phases, which are described as follows:

Slight soil limitation indicates properties favorable for rated use. The degree of limitation is minor and can be easily overcome. good performance and low maintenance can be expected.

Moderate soil limitation indicates properties moderately favorable for rated use. This degree of limitation can be overcome or modified by special planning, design or maintenance.

Severe soil limitation indicates one or more properties unfavorable for rated use. This degree of limitation generally requires major soil reclamation, special design, or intensive maintenance. Some of these soils can be improved by reducing or removing the soil feature that limits use, but, in most situations, it is both difficult and costly to alter the soil or to design a structure to compensate for a severe degree of limitation.

Explanation of ratings

1. Limitation ratings for spetic tank abosrption fields were based on amount of slope, percolation rate and flood hazard, if known. Notations were also made where pollution became a hazard.

2. Limitation ratings for sewage lagoons were based on the same criteria as septic tank absorption fields. In the case of sewage lagoons, however, high percolation rates were considered a liability and not an asset. Pollution hazard areas were also noted.

3. Limitation ratings for shallow excavations were based on slope, flood hazard, resistance to sloughing, workability, and absence of rocks.

4. Limitation ratings for dwellings were based on slope, flooding potential, presence of expansive clays, rockiness, and depth to bedrock.

5. Limitation ratings for trench-type sanitary landfills were based on amount of slope, permeability, drainage, depth to bedrock, and flooding. Areas with pollution hazard were also noted.

6. Limitation ratings for area-type sanitary landfills used the same criteria as those for trench-type sanitary landfills. However, gentler slopes

were required for area-type sanitary landfills rather than trench-type sanitary landfills. Notations were also made for areas that could be a pollution hazard.

7. Limitation ratings for soils as sources of cover material for area-type sanitary landfills were based on slope, depth, and stoniness.

8. Limitation ratings for local roads and streets were based on slope, frequency of flooding, presence of gypsum and presence of expansive clays.

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau impact area

GENERAL DATA											Soil Limitation Ratings							
				TEXTURE														
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	¼-4 inches	4 ERD	Percent Slope	Est. Sed. Yield A.F./mi²	% Prob. Success for Seeding	Erosion Suscep- tibility	Hydro- logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwelling	Trench- type Sanitary Landfill	Area- type Sanitary Landfill	Cover Material for Area- type Sanitary Landfill	Local Roads & Streets
A	2,690	Moderate	16"+	Moderate- coarse	Medium	3-8	0.4-0.5	30-50 due to low rainfall	Moderate	B	Slight	Mod. due to slope	Slight	Slight	Slight	Slight	Slight	Slight
B	6,080	Slight	16"+	Medium	Medium	1-3	0.3-0.4	30-50 due to low rainfall	Moderate	B	Slight	Mod. due to high Perm.	Slight	Slight	Slight	Slight	Slight	Slight
C	47,340	Moderate	12"-15"	Moderate- Coarse	Moderate- Coarse	3-8	0.4-0.5	30-50 due to water holding capacity	Slight	B	Slight	Mod. due to slope	Slight	Slight	Slight	Slight	Slight	Slight
D	15,000	Moderate	12"-15"	Moderate- Coarse	Medium	8-15	0.55-0.65	30-50 due to low rainfall	Moderate	B	Mod, due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Slight	Mod. due to slope	Mod. due to slope	Moderate due to slope
E	14,560	Moderate	12"-15"	Medium	Mod.- Fine	3-8	0.45-0.55	30-50 due to low rainfall	Mod.	C	Mod. due to low Perm.	Mod. due to slope	Slight	Slight	Slight	Slight	Slight	Slight
F	1,800	Slight	12'-15'	Medium	Medium	1-3	0.35-0.45	< 30% due to low rainfall	Mod.	B	Slight	Mod. due to high perm.	Slight	Slight	Slight	Slight	Slight	Slight
G	530	Moderate	12"-15"	Moderate- Fine	Moderate- Fine	3-8	0.5-0.6	30-50 due to rainfall	Mod.	C	Mod. due to low perm.	Mod. due to slope	Slight	Slight	Slight	Slight	Slight	Slight
H	6,160	Moderate	12"-15"	Moderate- Fine	Fine	1-3	0.4-0.5	30-50 due to low rainfall	Moderate	D	Severe due to low perm. & rare flooding	Moderate due to rare flooding	Severe due to rare flooding	Severe due to rare flooding	Moderate due to rare flooding	Moderate due to rare flooding	Slight	Moderate due to rare flooding

(continued)

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau Impact Area

GENERAL DATA												Soil Limitation Ratings							
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	TEXTURE ¼-4 inches	TEXTURE 4 ERD	Percent Slope	Est. Sed. Yield A.F./mi^2	% Prob. Success for Seeding	Erosion Susceptibility	Hydrologic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwelling	Trench-type Sanitary Landfill	Area-type Sanitary Landfill	Cover Material for Area-type Sanitary Landfill	Local Roads & Streets
I	25,315	Slight-Moderate	10"-11"	Moderate Coarse	Medium	3-8	0.4-0.5	< 30 due to low Rainfall	Moderate	B	Slight-Pollution Hazard Near Res.	Moderate due to slope & Flooding Near Res.	Slight Mod near Res. due to Flooding	Slight severe Near Res. due to Flooding	Slight severe Near Res. due to Flooding	Slight Mod near Res. due to Flooding	Slight	Slight Mod near Res. due to Flooding
J	3,040	Moderate	10"-11"	Moderate Coarse	Medium	8-15	0.45-0.55	30-50 due to low Rainfall	Moderate	B	Moderate due to Slope	Moderate due to Slope	Moderate due to Slope	Moderate due to Slope	Slight	Moderate due to Slope	Moderate due to Slope	Moderate due to slope
K	47,100	Moderate	10"-11"	Medium	Medium	3-8	0.4-0.5	30-50 due to low Rainfall	Moderate	B	Slight	Moderate due to slope	Slight	Slight	Slight	Slight	Slight	Slight
L	7,600	Critical	10"-11"	Moderate Fine	Moderate Fine	8-15	0.45-0.55	30-50 due to low Rainfall	Moderate	C	Moderate due to slope	Moderate due to slope	Moderate due to slope	Moderate due to slope	Slight	Moderate due to slope	Moderate due to slope	Moderate due to slope
M	1,180	Moderate	4"-9"	Moderate Coarse	Medium	15-30	0.55-0.65	< 30 due to Shallow Depth	Moderate	B	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope
N	4,070	Moderate	4"-9"	Medium	Medium	15-30	0.6-0.7	< 30 due to slope	Moderate	B	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to Slope	Severe due to slope
O	23,970	Severe	12"-15"	Moderate Coarse	Moderate Coarse	8-15	0.6-0.7	30-50 due to low Rainfall	Moderate	C	Moderate due to slope & Gypsum Present	Moderate due to slope & Gypsum Present	Moderate due to slope & Gypsum Present	Moderate due to slope & Gypsum Present	Slight	Moderate due to slope & Gypsum Present	Moderate due to slope & Gypsum Present	Moderate due to slope & Gypsum Present
P	8,660	Moderate	10"-11"	Moderate Coarse	Moderate Coarse	1-3	0.35-0.45	< 30 due to low Rainfall	Slight	C	Slight	Moderate due to slope & Gypsum Present	Slight except where Gypsum Present	Slight	Slight	Slight	Slight	Slight except where Gypsum Present

(continued)

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau Impact Area

GENERAL DATA												Soil Limitation Ratings							
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	TEXTURE ¼-4 inches	TEXTURE 4 ERD	Percent Slope	Est. Sed. Yield A.F./mi^2	% Prob. Success for Seeding	Erosion Suscep- tibility	Hydro- logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwelling	Trench- type Sanitary Landfill	Area- type Sanitary Landfill	Cover Material for Area- type Sanitary Landfill	Local Roads & Streets
Q	5,050	Critical	10"-11"	Moderate- Coarse	Mod.- Coarse	15-30	0.45-0.55	< 30 due to low rainfall & steep slope	Moderate	C	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Moderate due to slope	Severe due to slope	Severe due to slope	Severe due to slope
R	11,770	Moderate	10"-11"	Mod.- Coarse	Medium	15-30	0.5-0.6	< 30 due to low rainfall & steep slope	Moderate	C	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Moderate due to slope	Severe due to slope	Severe due to slope	Severe due to slope
S	17,440	Moderate	10"-11"	Medium	Medium	8-15	0.45-0.55	30-50 due to low rainfall	Moderate	C	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Slight	Mod. due to slope	Mod. due to slope	Mod. due to slope
T	15,460	Moderate	4"- 9"	Medium	Medium	3-8	0.5-0.6	< 30 due to low pro- ductivity potential	Moderate	C	Slight	Mod. due to slope	Slight	Slight	Slight	Slight	Slight	Slight
U	1,560	Critical	10"-11"	Medium	Mod.- Fine	30-45	0.6-0.7	< 30 due to steep slope	Severe	D	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope
V	6,120	Critical	4"- 9"	Medium	Mod. - Fine	15-30	0.9-1.0	< 30 due to steep slope	Severe	D	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope
W	26,110	Slight	16" +	Mod.- Coarse	Medium	1-3	0.3-0.4	30-50 due to low rainfall	Moderate	A	Slight	Slight Mod. when gypsum pres.	Slight	Slight Severe where gypsum pres.	Slight	Slight	Slight	Slight Severe where gypsum pres.
X	4,980	Moderate	16" +	Coarse	Mod. - Coarse	3-8	0.4-0.5	30-50 due to low rainfall	Moderate	A	Slight pollu- tion haz. near res.	Mod. due to slope pollution haz.	Slight	Slight	Slight pollu- tion haz. near res.	Slight pollu- tion haz. near res.	Slight	Slight

(continued)

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau Impact Area

		GENERAL DATA										Soil Limitation Ratings							
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	TEXTURE ¼-4 inches	TEXTURE 4 ERD	Percent Slope	Est. Sed. Yield A.F./mi^2	% Prob. Success for Seeding	Erosion Suscep-tibility	Hydro-logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwellings	Trench-type Sanitary Landfill	Area-type Sanitary Landfill	Cover Material for Area-type Sanitary Landfill	Local Roads & Streets
Y	6,840	Slight	12"-15"	Coarse	Mod. - Coarse	3-8	0.3-0.4	< 30 due to low rainfall	Slight	B	Slight Pollution haz. near res.	Mod. due to slope	Slight	Slight Mod. when gypsum pres.	Slight	Slight	Slight	Slight-Mod. where gypsum pres.
Z	6,460	Moderate	12"-15"	Mod. - Coarse	Mod. - Coarse	1-3	0.3-0.4	< 30 due to low rainfall	Slight	B	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Slight
AA	16,970	Moderate	4"-9"	Mod. - Coarse	Mod. - Coarse	3-8	0.35-0.45	< 30 due to low rainfall	Slight	B	Mod.- rare flooding poll. haz near res.	Mod. due to slope	Mod. rare flooding	Severe rare flooding	Mod.- rare flooding Pollution hazard near res.	Mod. rare flooding pollution hazard near res.	Slight	Mod. rare flooding
BB	5,890	Moderate	4"-9"	Mod. - Coarse	Medium	1-3	0.35-0.45	< 30 due to low rainfall	Slight	B	Slight	Mod. due to high perm.	Slight	Slight	Slight	Slight	Slight	Slight
CC	10,440	Moderate	4"-9"	Medium	Medium	1-3	0.35-0.45	< 30 due to low rainfall	Moderate	B	Slight poll. haz. near res.	Mod. due to high perm.	Slight	Slight	Slight poll. haz. near res.	Slight poll. haz. near res.	Slight	Slight
DD	3,570	Moderate	4"-9"	Mod. - Coarse	Medium	8-15	0.45-0.55	< 30 due to low rainfall	Moderate	B	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Slight	Mod. due to slope	Mod. due to slope	Mod. due to slope
EE	4,710	Severe	4"-9"	Medium	Mod. - Fine	3-8	0.9-1.0	< 30 due to low rainfall	Moderate	C	Mod. due to low perm.	Mod. due to slope	Slight	Severe due to expansive clays	Severe due to expansive clays	Slight	Severe due to expans. clays	severe due to expans. clays

(continued)

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau Impact Area

				GENERAL DATA							Soil Limitation Ratings								
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	TEXTURE ¼-4 inches	TEXTURE 4 ERD	Percent Slope	Est. Sed. Yield A.F./mi^2	% Prob. Success for Seeding	Erosion Suscep-tibility	Hydro-logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwelling	Trench-type Sanitary Landfill	Area-type Sanitary Landfill	Cover Material for Area-type Sanitary Landfill	Local Roads & Streets
FF	3,430	Moderate	10"-11"	Medium	Medium	1-3	0.35-0.45	30-50 due to low rainfall	Moderate	B	Slight	Moderate due to high perm.	Slight	Slight	Slight	Slight	Slight	Slight
GG	52,860	Moderate	4"-9"	Medium	Medium	8-15	0.55-0.65	< 30% due to low rainfall	Moderate	B	Mod due to slope Poll Haz near res.	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope
HH	2,580	Moderate	10"-11"	Medium	Mod.- Coarse	1-3	0.35-0.45	30-50 due to low rainfall	Moderate	B	Slight	Mod. due to high perm.	Slight	Slight	Slight	Slight	Slight	Slight
II	8,390	Moderate	4"-9"	Medium	Mod.- Fine	8-15	0.8-0.9	< 30 due to low rainfall	Moderate	C	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Slight	Mod. due to slope	Mod. due to slope	Mod. due to slope
JJ	4,400	Critical	4"-9"	Mod. - Fine	Medium	15-30%	0.9-1.0	< 30 due to low rainfall	Severe	C	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Mod. due to slope	Severe due to slope	Severe due to slope	Severe due to slope
KK	12,500	Slight	4"-9"	Mod.- Fine	Mod.- Fine	3-8	0.6-0.7	< 30 due to low rainfall	Moderate	C	Mod due to low perm. Poll. haz. near res.	Mod. due to slope	Slight Expans.	Severe Expans. clays	Severe Expans. clays	Slight	Severe Expans. clays	Severe Expans. clays
LL	10,710	Slight	4"-9"	Mod.- Fine	Mod. - Fine	8-15	0.7-0.8	< 30 due to low rainfall	Moderate	C	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Slight	Mod. due to slope	Mod. due to slope	Mod. due to slope
MM	5,130	Slight	4"-9"	Mod. - Fine	Mod. - Fine	15-30	0.75-0.85	< 30 due to low rainfall & slope	Severe	C	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Mod. due to slope	Severe due to slope	Severe due to slope	Severe due to slope

(continued)

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau Impact Area

GENERAL DATA												Soil Limitation Ratings							
MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	TEXTURE		Percent Slope	Est. Sed. Yield A.F./mi^2	% Prob. Success for Seeding	Erosion Suscep-tibility	Hydro-logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwelling	Trench-type Sanitary Landfill	Area-type Sanitary Landfill	Cover Material for Area-type Sanitary Landfill	Local Roads & Streets
				¼-4 inches	4 ERD													
NN	7,100	Critical	4"-9"	Fine	Fine	3-8	0.9-1.0	< 30 due to low rainfall	Moderate	D	Severe due to low perm.	Mod. due to slope	Slight	Severe Expans. clays	Severe Expans. clays	Slight	Severe Expans. clays	Severe Expans. Clays
OO	6,400	Moderate	12"-15"	Medium	Mod.- Fine	1-3	0.5-0.6	< 30 due to low rainfall	Moderate	C	Mod. due to low perm.	Slight	Slight	Slight- except where gypsum	Slight	Slight	Slight -	Slight except where gypsum
PP	3,150	Critical	10"-11"	Medium	Medium	15-30	0.7-0.8	30-50 due to low rainfall & steep slope	Moderate	C	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Mod. due to slope	Severe due to slope	Severe due to slope	Severe due to slope
QQ	8,470	Critical	10"-11"	Medium	Mod. - Fine	8-15	0.45-0.55	30-50 due to low rainfall	Moderate	C	Mod. due to slope	Mod. due to slope	Mod. due to slope	mod. due to slope	slight	mod. due to slope	mod. due to slope	Mod. due to slope
RR	12,830	Mod. 0 Critical	10"-11:	Medium	Mod. - Fine	15-30	0.6-0.7	30-50 due to low rainfall & steep slope	Moderate	C	Severe due to slope	Severe due to slope	Severe due to slope	Severe due to slope	Moderate due to slope	Severe due to slope	Severe due to slope	Severe due to slope
SS	2,810	Mod. - Critical	4"-9"	Mod. - Coarse	Mod. - Coarse	1-3	0.3-0.4	< 30 due to low rainfall	Slight	C	Slight	Slight	Slight	Slight	Slight	Slight	Slight	Slight
TT	2,390	Critical	4"-9"	Mod. - Coarse	Mod. - Coarse	8-15	0.4-0.5	< 30 due to low rainfall	Slight	C	Mod. due to slope	Mod. due to slope	Mod. due to slope	Mod. due to slope	Slight	Mod. due to slope	Mod. due to slope	Mod. due to slope

(continued)

FIGURE 3

Soils Interpretation Data
Kaiparowits Plateau Impact Area

MAP SYMBOL	Acres	Present Erosion Condition	Effective Root Depth (ERD)	TEXTURE ¼-4 inches	TEXTURE 4 ERD	Percent Slope	Est. Sed. Yield A.F./mi^2	% Prob. Success for Seeding	Erosion Suscep-tibility	Hydro-logic Soil group	Septic Tank Absorp. Fields	Sewage Lagoons	Shallow Excavation	Dwelling	Trench-type Sanitary Landfill	Area-type Sanitary Landfill	Cover Material for Area-type Sanitary Landfill	Local Roads & Streets
GENERAL DATA												Soil Limitation Ratings						
UU (Steep & Rocky)	163,000	Critical	4"-9"	--	--	35-65	1.0-1.5	--	Severe	D			Severe due to steep slopes and high amounts of rock					
VV Rock outcrops	28,800	--	--	--	--	--	--	--	--	D			Severe due to lack of permiability and being solid rock					
WW Saline Flats	12,800	--	--	--	---	--	--	--	--	D			Severe due to poor drainage and presence of expansive clays					
TOTAL	705,525																	

APPENDIX II-5

Technical Description of Soil Associations

APPENDIX II-5

Soils

Kaiparowits Plateau impact area

Technical description of soil associations (Wilson, et al., 1975)

Deep Plateau Soils Association

Soils mapped by symbols "A" through "N" belong to the Ustic Torrifluvents-Ustic Torriorhents Soil Association. This association consists of about 70 percent Ustic Torrifluvents, 20 percent Ustic Torriorthents and 10 percent Ustollic Camborthids and Ustollic Calciorhids. (See Glossary in Appendix for definitions of soils names and terminology.)

Ustic Torrifluvents are deep, mildly and moderately alkaline soils. Surface layers are light brownish-gray, light-brown, light reddish-brown and reddish-brown fine sandy loams, loams, silt loams and silty clay loams. Subsoils are light reddish-brown, light grayish-brown and pinkish-gray fine, fine silty, fine loamy and coarse loamy. Substrata are light reddish-brown, light brownish-gray and pinkish-gray fine, fine silty, fine loamy and coarse loamy.

Ustic Torriorthents are deep, mildly and moderately alkaline soils. Surface layers are light brownish-gray, light-brown, light reddish-brown and reddish-brown, fine sandy loams and silty clay loams. Subsoils are light reddish-brown, light grayish-brown and pinkish-gray fine loamy, fine silty and coarse loamy. Substrata are light reddish-brown, light brownish-gray and pinkish-gray fine loamy, fine silty, coarse loamy and loamy skeletal.

Soils in this association are well and moderately well drained. Permeability is slow to moderately rapid. Runoff is slow to medium and sediment production is moderate to high. Hydrologic groups are mainly B and C.

Shallow Plateau Soils Assocation

Soils mapped by symbols "O" through "T" belong to the Lithic Ustollic Calciorthids - Lithic Ustic Torriorthents Soil Association. This association consists of about 35 percent Lithic Ustollic Calciorthids, 20 percent Lithic Ustic Torriorthents, 20 percent Ustollic Calciorthids, 15 percent Ustollic Haplargids and 10 percent Ustic Torriorthents.

Lithic Ustollic Calciorthids are shallow, mildly and moderately alkaline soils. Surface layers are reddish-brown, angular, very cobbly, fine sandy loam. Subsoils are reddish-brown and pink-loamy skeletal, underlain by fractured bedrock at depths of 10 to 20 inches.

Lithic Ustic Torriorthents are shallow, mildly and moderately alkaline soils. Surface layers are brown and reddish-brown, very gravelly loams. Subsoils are pale-brown loam skeletal, underlain by bedrock at depths of 10 to 20 inches.

Ustollic Calciorthids are moderately deep and deep, mildly and moderately alkaline soils. Surface layers are yellowish-red and reddish-brown very fine sandy loams. Subsoils are red and yellowish-red fine loamy and coarse loamy. Calcium carbonate layers occur between depths of six to 18 inches.

Ustollic Haplargids are deep and moderately deep, mildly and strongly alkaline soils. Surface layers are light brown, very pale brown, and reddish-brown fine loamy and loamy skeletal. Substrata are very pale brown, light gray and pinkish-gray, fine loamy, loamy skeletal and sandy or sandy skeletal. Calcium carbonate layers occur between depths of 12 to 24 inches.

Soils in this association are well drained. Permeability is moderate to rapid. Runoff is medium to rapid and sediment production is moderate to low. Hydrologic groups are mainly C for the Ustollic Calciorthids and Lithic Ustic Torriorthents.

Shallow Soil-Rock Outcrop Soil Association

Soils mapped by symbols "U" and "V" belong to the Ustic Torriorthents Shallow Soil-Rock Outcrop Soil Association. This association consists of about 60 percent Ustic Torriorthents (shallow), 15 percent Rock Outcrop and 25 percent Typic Ustorthents and Typic Haploborolls.

Ustic Torriorthents (shallow) are mainly shallow but some are moderately deep, mildly to moderately alkaline soils. Surface layers are light brownish-gray and light yellowish-brown loams, silt loams, and silty clay loams. Subsoils are pale brown, light grayish-brown and brownish-gray, loamy and clayey. Underlying shale and interbedded sandstone occur mainly within a depth of 20 inches.

Soils in this association are well drained. Permeability is moderate to very slow. Runoff is moderate to high and sediment production is high. The hydrologic group mainly D.

Sandy Soil Association

Symbol "W" represents Sandy Soil Association and belongs to the Typic Torripsamments - Typic Torriorthents Soil Association. This association consists of 60 percent Typic Torripsamments, 20 percent Typic Torriorthents and 20 percent mainly Lithic Calciorthids and Typic Calciorthids.

Typic Torripsamments are deep, mildly to moderately alkaline soils. Surface layers are yellowish-red loamy fine sands. Subsoils are yellowish-red and sandy. Substrata are yellowish-red and sandy.

Soils in this association are excessively drained. Permeability is rapid. Runoff is slow to medium and sediment production is low. The hydrologic group is mainly A.

Badland-Rockland Association

Soils mapped by symbols "X" through "WW" belong to the Badland-Rockland Assocation. Bare rock outcrops cover approximately 30 to 50 percent of the area. Shallow and very shallow soils over sandstone bedrock comprise about 20 to 40 percent. About five to 10 percent is deep and moderately deep soils.

Runoff is high and resultant heavy sediment production is a major problem in these areas.

APPENDIX II-6

Soils Associations, Groups and Interpretations-Transmission System

APPENDIX II-6

Soils

Soils associations groups and interpretations - transmission system

Soil association descriptions for Arizona and Nevada:

Unit 1 - Anthony-Vinton-Aqua Soil Association.

This unit consists of deep soils on alluvial fans and low terraces. Slopes range from zero to five percent. The unit is made up of 35 percent Anthony, 30 percent Vinton, 20 percent Aqua, and 15 percent consists of intermixed areas of Gila, Glendale, Cave, and Rillino soils. The Anthony, Vinton, and Aqua soils range from sandy loams to loams and are deep (over 60 inches). The three soils have moderately rapid permeability, moderate to low water-holding capacities, and are in hydrologic group B (moderately slow runoff). Revegetation would be difficult due to low water-holding capacity and low annual precipitation.

Unit 1A - Cabezon-Springerville-Thunderbird Soil Association.

These soils are shallow to moderately deep and on slopes from zero to 30 percent. They are developed on basaltic formations. The Cabezon soils are shallow, cobbly, or stony loam or clay loam over fractured basalt bedrock. The Springerville and Thunderbird soils are moderately deep, gravelly on cobbly clays to clay loams. These soils are in hydrologic group D with rapid runoff. This soil association is in the slight to low moderate erosion condition classes. On lower slopes the soils have a very slight erosion hazard and on the higher slopes the erosion hazard is moderate. The estimated sediment yield is less than .2 acre-feet per square mile per year. These soils can be revegetated using good conservation methods.

Unit 1B - Sizer-Rudd-Bandera Soil Association

The soils are gravelly or cindery loamy, formed on cinders or basalt. Sizer and Rudd soils make up 35 percent each of the unit and Bandera soils, 20 percent. Ten percent is alluvial soils in drainage ways and washes. Sizer soils are gravelly silt loam over cinders or very cindery coarse-textured material. These soils are found on sides and bases of cinder cones with slopes of five to 30 percent. The Rudd soils are gravelly to very gravelly loams that are strongly calcarcous over fractured bedrock. They are on basaltic plateaus or plains with slopes of zero to five percent. The Bandera soils are very similar to Sizer but are more cindery throughout and have slopes from five to 45 percent. The unit's soils have a moderate to high available water capacity and moderately slow to moderately high permeability. The Sizer and Bandera soils are in hydrologic group B, well drained soils with moderate infiltration rates; Rudd soils are in hydrologic group D, with rapid runoff. The erosion condition is slight to moderate and the erosion susceptibility is slight in most areas and moderate on slopes greater than 30 percent. Estimated sediment yield is .2 to .5 acre-feet per square mile per year. These soils can be revegetated with extreme care. They are coarse textured with a moderate to low water-holding capacity.

Unit 1D - Brolliar-Sponseller Soil Association.

The soils are moderately deep over basaltic or cindery materials. Brolliar soils make up 60 percent and Sponseller soils 30 percent; the remaining 10 percent is made up of rock outcrops and alluvial soils in drainages and small basins. Brolliar soils are cobbly or stony loams with clay loam to clay subsoils. Sponseller soils are very similar to the Brolliar except for color. Sponseller soils are reddish-brown and Brolliar soils are dark colored. Slopes range from zero to 30 percent. Brolliar soils are in hydrologic group D with rapid runoff; and Sponseller soils are in hydrologic group B with well drained soils and moderate infiltration rates. This soil association is in the slight to moderate erosion class, but when disturbed, the erosion hazard for Brolliar soils is severe on slopes over eight percent, and Sponseller soils on slopes over 30 percent. The estimated sediment yield is .2 to .5 acre-feet per square mile per year. Both soils can be revegetated on lesser slopes with a higher percent of success than on higher slopes, using water control measures. Both soils have high water-holding capabilities and annual precipitation is about 18 to 26 inches.

Unit 2 - Cave Soil Association.

This unit consists of very shallow to shallow soils with lime hardpans on valley slopes and mesas. Slopes range from one to 30 percent. Cave soils make up 60 percent of the unit, the remaining 40 percent is made up of Winkel, Nickel, and small intermixed areas of other calcareous soils. Cave soils are shallow, gravelly, sandy loams over lime hardpans. Cave soils have very slow permeability, very low water-holding capacity, and are in hydrologic group D (rapid runoff). This association would be very difficult to revegetate.

Unit 2A - Winona-Boysag Soil Association.

This unit is made up of approximately 60 percent Winona gravelly or cobbly calcareous loams and 30 percent Boysag gravelly loams to sandy loams. Both soils are moderately shallow, underlain by fractured limestone and calcareous sandstone. The loams have moderate available water capacity, they clays have high available water capacity, moderate to slow permeability, slopes ranging from two to 15 percent with some area on the breaks up to 50 percent. Both soils are in hydrologic group D which indicate areas of rapid runoff. The erosion condition is slight to moderate and the soils have only slight to moderate erosion susceptibility when disturbed. Estimated sediment yield is .2 to .5 acre-feet per square mile per year. These soils would be difficult to revegetate due to shallowness to bedrock.

Unit 3 - Laveen-Corrizo-Antho Soil Association

This unit consists of deep soils on dissected terraces and alluvial fans. Slopes range from zero to eight percent but include short slopes up to 50 percent. The unit is made up of 40 percent Laveen, 25 percent Carrizo, 25 percent Antho, and 10 percent other soils and riverwash. Laveen soils are deep loams with moderate permeability, high water-holding capacity, and are in the hydrologic group B (moderately slow runoff). Corrizo soils are deep loamy, fine sands with rapid permeability, low water-holding capacity, and are in hydrologic group A (very slow runoff). Antho soils are sandy to gravelly sandy loams with moderately rapid permeability, moderate water-holding capacity, and are in hydrologic group B (moderately slow runoff). This unit would be difficult to revegetate due to low annual precipitation.

Unit 3A - Showlow-Pastura-Poley Soil Association

This unit consists of soils on upland plains that range from nearly level to rolling and moderately steep in dissected areas. The soils are deep and clayey except for areas having lime hardpans at shallow depths. The unit is made up of 60 percent Showlow, 20 percent Pastura, and 10 percent Poley. The remaining 10 percent is small areas of very gravelly Lynx like soils. The Showlow soils have a deep gravelly loam surface with heavy clay loam to clay subsoils. Permeability is slow, water-holding capacity high, and in hydrologic group C (moderately rapid runoff). Pastura soils are deep calcareous loams to gravelly loams over a lime hardpan at depths ranging from seven to 20 inches. Permeability is moderate to hardpan, water-holding capacity moderate, and in hydrologic group D (rapid runoff). Poley soils are deep, gravelly loams over clayey subsoils. Permeability is slow, water-holding capacity high, and in hydrologic group C (moderately rapid runoff). Erosion susceptibility is low to moderate when disturbed. Soils in this association could be revegetated with moderate success using good conservation practices.

Unit 4 - Springerville-Cabezon Soil Association.

The soils are moderately deep to deep cobbly and/or stony soils on basaltic mountain slopes. The association is composed of 60 percent Springerville, 30 percent Cabezon, and 10 percent other related soils. Springerville soils are deep granular clays with heavy high-swelling clay subsoils over basaltic bedrock, slopes ranging from one to 10 percent but usually five percent. Cabezon soils are shallow to very shallow, cobbly or stony loams to clay loams over basaltic bedrock, slopes ranging from five to 30 percent. These soils have slow permeability and are in hydrologic group D with rapid runoff. Present erosion condition is slight to moderate and the erosion hazard is severe when disturbed. Estimated sediment yield is .5 to 1.0 acre-feet per square mile per year. Springerville soils can be revegetated easier than Cabezon soils due to soil depth and water-holding capacity.

Unit 4A - Moenkopi - Rock Outcrop Soil Association.

This unit is made up of approximately 70 percent Moenkopi loamy sand and sandy loam, and the balance is rock outcrop and rough broken land. The soils are shallow to very shallow; they have moderate available water capacity, moderately rapid permeability, slopes ranging from two to 15 percent, and are placed in hydrologic group D, areas of rapid runoff. Erosion condition is moderate to severe and the soils are highly susceptible to wind erosion when disturbed. Estimated sediment yield is 1.0 to 3.0 acre-feet per square mile per year. These soils would be very difficult to revegetate due to low water-holding capacity and susceptibility to wind erosion.

Unit 4B - Palma-Clovis-Redbank Soil Association.

This Unit consists of deep sandy loam soils developed in alluvium from sandstone. The soils are in areas of high plains with slopes ranging from zero to 15 percent. The unit is 50 percent Palma, 30 percent Clovis, and 20 percent deep sandy loams and small areas of rough broken lands, terrace escarpments, and sandstone outcrops. Both Palma and Clovis soils have sandy loam surfaces with sandy loam to sandy clay loam subsoils. Palma soils have moderately rapid permeability, moderate water-holding capacity, and are in hydrologic group B (very little runoff). Clovis soils have moderate permeability, high water-holding capacity, and are in hydrologic group B (very little runoff). When disturbed these soils would be moderately susceptible to erosion. This association would revegetate easily using good conservation practices.

Unit 4C - Sheppard Rock Outcrop Soil Association.

This unit is primarily Sheppard loamy sand with 30 percent rock outcrop. The soils are deep, low in water capacity; they have moderately rapid to rapid permeability with slopes ranging from zero to 15 percent, and are placed in hydrologic group A, areas of little runoff. Slopes range from zero to 15 percent; the erosion condition is moderate to severe. These soils are highly susceptible to wind erosion when disturbed. Estimated sediment yield is from .2 to .5 acre-feet per square mile per year. These soils would be very difficult to revegetate due to their low water-holding capability and susceptibility to wind erosion.

Unit 4D - Rillito-Gunsight-Pinal Soil Association.

This association has soils that are deep and others shallow to a lime cemented hardpan (caliche) or very gravelly loams on old alluvium. This association is composed of 35 percent Rillito, 25 percent gunsight, 20 percent Pinal, and 20 percent other related soils. Rillito soils are deep gravelly loams with a mottled lime subsoil at about 12 inches, slopes ranging from zero to five percent. Gunsight soils are deep, calcareous gravelly loams with a mottled lime subsoil and substratum at about three inches, slopes ranging from zero to 10 percent.

Pinal soils are shallow to a lime hardpan at 12 inches, slopes ranging from zero to five percent. Rillito and Gunsight soils are in hydrologic group B with moderately slow runoff and Pinal soils are in hydrologic group D with rapid runoff. Present erosion condition is slight and erosion hazard is moderate when disturbed. The estimated sediment yield is less than .2 acre-feet per square mile per year. These soils would be difficult to revegetate due to low rainfall.

Unit 5 - Latene-Rilling-Cave Soil Association

This unit consists of deep and shallow or very shallow calcareous soils on dissected old terraces. Slopes range from zero to 15 percent but up to 50 percent on short side slopes or terrace sides. This unit is made up of 30 percent Latene, 30 percent Rillino, 15 percent Cave, and 25 percent small intermixed areas of gravelly Pinaleno, Nickel, and Continental soils on the uplands, and Anthony, Gila, and Vinton soils in drainage ways. Lateno soils are deep loams over strongly calcareous loam or sandy loam with caliche gravel. Rillino soils are very similar to Latene but contain more gravel and have a higher lime content. Cave soils are shallow calcareous gravelly loams with a hard caliche layer at four to 20 inches. Latene and Rillino soils are moderately permeable and have moderate water-holding capacity; both soils are in hydrologic group B (moderate to slow runoff). Cave soils have very slow permeability and a very low water-holding capacity. Cave soils are in hydrologic group D (rapid runoff). This association would be difficult to revegetate.

Unit 5A - Sedimentary Rock Outcrop and Rough Broken Land Soil Association.

These are small areas of shallow sandy loam soils on mesa tops. These soils fall in hydrologic group D, which are areas of runoff with very slow permeability. The slope is from three to 30 percent, the erosion condition is slight, and susceptibility to wind erosion is low, due to the large percent of rock outcrop. Estimated sediment yield is less than two acre-feet per square mile per year. This unit has a very low potential for revegetation due to shallow or no soil and very low water-holding capacity.

Unit 6 - Cellar-House Mountain-Rock Outcrop Soil Association.

This unit consists of very shallow to shallow soils and rock out-crops on hills and low mountains. Slopes range from five to 60 percent, or more, on the higher, rockier peaks. This unit is made up of 35 percent Cellar soils, 25 percent House Mountain soils, 20 percent Rock Outcrop. The remaining 20 percent is Lehmans and Chiricahua soils on the lower concave slopes and saddles, and gravelly alluvial and colluvial soils on toe-slopes and in drainage ways. Cellar soils are shallow, very gravelly sandy loam. House Mountain soils are shallow, cobbly loam over cobbly clay loam subsoil. This association is in hydrologic group D (rapid runoff) and is moderately susceptible to erosion when disturbed. These soils would be very difficult to revegetate.

Unit 7 - Barkerville-Moana Soil Association.

The unit is composed of shallow and very shallow rocky soils on granite and schist. The association consists of 70 percent Barkerville; 20 percent Moano, and 10 percent related soils. Barkerville soils are very shallow gravelly or cobbly sandy loams over strongly weathered granite which becomes consolidated at 20 to 40 inches. Slopes range from 20 to 60 percent. Moanao soils are very shallow, six to 16 inches, gravelly loams over schist or phyllite bedrock which is vertically fractured, slopes ranging from two to 60 percent. These soils have moderate to rapid permeability and are in hydrologic group D and C with moderate to rapid runoff. Both soils are in the moderate erosion class and are moderate to severe erosion hazard class when disturbed. Estimated sediment yield is .5 to 1.0 acre-feet per square mile per year. These soils can be revegetated because the fractured and weathered bedrock will retain moisture.

Unit 8 - Tortugas-Purner-Jack Soil Association.

The unit is comprised of shallow to moderately deep medium and fine textured soils on gently sloping to steep limestone and sandstone hills. The association consists of Tortugas soils, 40 percent' Purner soils, 25 percent, and Jack soils, 15 percent. The remaining 20 percent consists of rock outcrops and other related soils. Tortugas soils are shallow, six to 20 inches, very gravelly or cobbly loam over limestone bedrock. The slopes range from five to over 45 percent. Purner soils are shallow, seven to 18 inches, gravelly loam with a lime cemented layer over limestone or calcareous sandstone. Slopes range from five to 30 percent. These soils have moderate to slow permeability and are in hydrologic group D with rapid runoff. These soils are in the moderate erosion class on the lower slopes and in the severe class on the higher slopes, and moderate to high erosion hazard class when disturbed. The estimated sediment yield is .2 to .5 acre-feet per square mile per year. Jack soils would be much easier to revegetate than the Tortugas and the Purner due to their depth and water-holding capacity.

Unit 9 - Moenkopi-Shalet Soil Association.

This unit consists of very shallow to shallow soils on sandstone and shale uplands. Slopes range from two to 15 percent but with short steep slopes on the sides of mesas and escarpments. The unit is made up of 45 percent Moenkopi, 30 percent Shalet, and 25 percent rock outcrops and deep soils in drainage ways. Moenkopi soils are shallow sandy loams over sandstone with moderately rapid permeability, very low water-holding capacity, and are in hydrologic group D (rapid runoff). Shalet soils are shallow loams over shale with slow permeability very low water-holding capcity, and are in hydrologic group D (rapid runoff). This unit would be difficult to revegetate due to low water-holding capacity.

Unit 10 - Pastura-Abra-Lynx Soil Association.

The unit is small and consists of shallow to deep, medium to fine textured alluvial soils. Pastura and Abra soils make up 35 percent each of the unit; the Lynx soils 20 percent, and 10 percent is scattered small areas of other related soils. Pastura soils are shallow gravelly loams with an extremely hard caliche pan at seven to 12 inches, and slopes one to 15 percent. The soils are moderately permeable and are in hydrologic group D with rapid runoff. Abra soils are loams to gravelly loams with strong lime zones containing many soft to hard lime segregations at eight to 28 inches and slope zero to 15 percent. The soils are moderately permeable and are in hydrologic group C with moderately rapid runoff. Lynx soils are deep loams to clay loams over clay loam subsoil in flood plains and swales with slopes from zero to three percent. Lynx soils are subject to flooding and water erosion. These soils are moderately permeable and are in hydrologic group B with moderate runoff. This unit is in the slight erosion class except for floodplains and swales which are moderate; the unit has a moderate to severe erosion hazard. The estimated sediment yield is .5 to 1.0 acre-feet per square mile per year. This unit would revegetate using good conservation methods.

Unit 11 - Lonti-Balon-Lynx Soil Association.

The soils are deep, moderately fine textured, developed in old and recent alluvium. The association is composed of 70 percent Lonti, 15 percent Balon, and 15 percent Lynx. Lonti soils are deep gravelly or cobbly loams with clay to gravelly clay subsoils, slopes ranging from one to 35 percent. Balon soils are deep sandy clay loams with clay laom to gravelly clay loam subsoils, slopes ranging from two to 30 percent. Lynx soils are deep loam to clay loam surface and subsoils, slopes ranging from zero to three percent. These soils have moderate permeability and are in hydrologic class B, medium runoff. Present erosion condition is moderate and the erosion hazard is moderate when disturbed. These soils can be revegetated but rainfall is low.

Unit 12 - Antho-Vint-Gilman Soil Association.

This unit consists of deep soils or floodplain and lower alluvial fans. Slopes range from zero to five percent. The unit is made up of 50 percent Antho, 30 percent Vint, 10 percent Gilman, and 10 percent intermixed areas of very sandy soils. Antho soils are deep sandy loams with moderately rapid permeability, moderate water-holding capacity, and are in hydrologic group B (moderately slow runoff). Vint soils are deep loamy sands with moderate rapid permeability, low water-holding capacity, and are in hydrologic group B (moderately slow runoff). Gilman soils are deep loams with moderate permeability, high water-holding capacity, and are in hydrologic group B (moderately slow runoff). This unit would be difficult to revegetate due to low annual precipitation.

Unit 13 - Cellar-Lehmans-Rock Outcrop Soil Association.

The soils are shallow to very shallow, very gravelly or cobbly and rock outcrop on gently sloping to very steep volcanic mountains and low hills. The association is composed of 25 percent Cellar, 20 percent Lehmans, 35 percent Rock Outcrop, and 20 percent other related soils. Cellar soils are very shallow, very gravelly, very cobbly, or very stony sandy loam on granite or gneiss bedrock at eight inches. Lehmans soils are shallow, cobbly loam underlain by andesite, basalt, or tuff at 14 inches. Rock Outcrop is a sandy type consisting of exposures of bedrock. The permeability of these soils is slow and they are in hydrologic group D with rapid runoff. Present erosion condition is slight and the erosion hazard when disturbed would be severe. Estimated sediment yield is .2 to .5 acre-feet per square mile per year. The lower desert area would be very difficult to revegetate.

Unit 14 - Winkel - Rockland Soil Association.

These soils are well drained, gently sloping to steep, shallow, gravelly fine sand loams and rockland on mesas and mountain slopes of the desert basin. It is about 50 percent Winkel soils and about 30 percent Rockland. Winkel soils are formed in material weathered from basalt and limestone, mixed with sandy eolian material. Winkel soils occur on mesas and lower mountain slopes. They are shallow and well drained. Surface layer is reddish-brown, very gravelly fine sandy loam. An indurated carbonate cemented hardpan occurs at depths of 11 to 19 inches. The Rockland is mainly outcrops of basalt and limestone and areas of very shallow soil material over basalt or limestone. This association is in hydrologic group D.

Unit 15 - Barkerville-Gaddes-Rock-Outcrop Soil Association.

This unit consists of very shallow to moderately deep soils and rock outcrops on granitic hills and mountains. Slopes range from 15 to 60 percent or more. The unit is made up of 45 percent Barkerville soils, 15 percent Gaddes soils, 15 percent Rock Outcrop, and 25 percent Mirabal, Faraway, and Luzena soils. Barkerville soils are shallow sandy loams over weathered granite. Gaddes soils have a sandy loam surface over gravelly clay loam subsoils over weathered granite at 20 to 40 inches. Soils in this unit are moderate to slow in permeability, have low to very low water-holding capacity, and are in hydrologic group C (moderately rapid runoff). This unit would be difficult to revegetate.

Unit 16 - Curhollow-Pastura-Magotsu Soil Association.

These soils are well drained, nearly level to steep, shallow gravelly loams, gravelly fine sandy loams, and cobbly or very cobbly loams or mesas, alluvial fans and mountain slopes of the uplands. Soils of this association are cominantly formed in residum or alluvium from basalt or mixed sedimentary ingenous rock. Most of the soils have indurated carbonate cemented hardpan and depth of 10 to 20 inches. Curhollow soils are old alluvial fans and desert mountain slopes, shallow, well drained, gravelly fine sandy loam surface, hardpan at 10 to 20 inches. They comprise 20 percent of this unit. Pastura soils are on basalt flow mesas. They are shallow, well drained, brown gravelly loams, and have an indurated, carbonate cemented hardpan at a depth of 10 to 20 inches. Mogotsu soils occur on basalt flow mesas. They are shallow, well drained, dark brown, very cobbly loam surface layers and light clay or cobbly and gravelly clay loam subsoils over an indurated carbonate-cemented hardpan. Depth to hardpan is 15 to 20 inches. This association is in the D hydrologic group.

Unit 18 - Rough Broken Stone Land Soil Association.

These soils border the bench lands and their escarpments. Under this association are included lands which have outcroppings of bedrock, and steep slopes that are badly cut by erosion, thus lessening agricultural value. A solid lime-cemented hardpan within a foot of the surface is typical of the flat areas. The materials vary greatly in origin, color, and texture, ranging from stone and gravel to silt and clay. Many of them are old deposits firmly cemented with lime. Along the lower valley sedimentary rock materials predominate, but in the upper valley much basalt and igneous materials are present.

Unit 19 - Las Vegas Gravelly Fine Sandy Loam Soil Association.

The Las Vegas gravelly fine sandy loam association occurs principally as high benchlands. The surface is fairly level or gently rolling, surface drainage is good, and there are no accumulations of alkali. It has a surface concentration of "desert pavement" of angular or slightly rounded dark colored gravel stones. Between the stones on the surface is a loose covering of fine sand or fine sandy loam material. This surface material is underlain by a thin layer of compact, heavy, fine sandy loam materal containing considerable gravel and caliche. This is underlain by a massive lime-cemented gravel hardpan which usually is very thick. The hardpan underlying these soils has only slight limitations as foundation-bearing material for most construction but hampers underground facilities. This hardpan is too thick and hard to be shattered by ordinary ripping equipment.

Unit 20 - Corrizo-Tonopah-Pittman Soil Association.

These soils are very deep to shallow gravelly and sandy soils on nearly level to strongly sloping terraces. They are shallow soils underlain by a hardpan or cemented gravel. Carrizo soils make up approximately 78 percent of the association; they are gravelly, coarse textured, excessively drained, slightly micaceous, and mildly calcareous. Pittman soils are cobbly, stony, coarse textured and calcareous. These soils are gravelly or cobbly, and too droughty to be used for agriculture. Pittman soils are a fair to good source of sand and gravel for concrete aggregate. They have slight to moderate limitations as foundation-bearing material.

There is no sulfate hazard to concrete. Toponah soils are very gravelly, coarse textured, calcareous [illegible] excessively drained. They comprise 12 percent of this unit.

Unit 21 - Rudd-Cabezon Association

This unit is made up of approximately 50 percent Rudd soils, 20 percent Cabezon soils and the remaining 30 percent is 15 percent cindery soils, similar to the Bandera series, 10 percent Rock outcrop and very shallow soils and five percent other soils. Rudd soils are gravelly to very gravelly loams that are strongly calcareous over fractured bedrock. They are found on basaltic plateaus or plains with slopes of zero to five percent. Cabezon soils are shallow, cobbly or stony loam or clay loam over fractured basalt bedrock. These soils are found between ledges of rock outcrop and on hills and mesa sides with slopes of eight to 30 percent. The estimated sediment yield is .2 to .5 acre-feet per square mile per year. These soils would be difficult to revegetate due to low water-holding capacity and shallow depths.

Mapping unit descriptions for California by soil groups

AC - Anthony-Cajon Arizo Association: Alluvial

Surface and subsoil textures vary from sandy loam to gravelly sand. This association occurs on nearly level to moderate sloping alluvial fans. These soils are susceptible to compaction and the erosion and siltation potential is high. The even distribution of coarse fragements and soil particles make it susceptible to compaction and decreases its percolation rate. This association is a high ORV impact area.

AM - Adelanto-Mohave Garlock Association: Red Desert

Surface textures vary from sandy to sandy loam and subsoil textures vary from sandy loam to sandy clay. This area is rated low in ORV impact and erosion and siltation potential because of the high concentration of similar size soil particles in its surface that are undisturbed because of ORV use. These soils occur on nearly level to gently sloping alluvial fans and plains.

AX - Aqua Dulce-Rough Broken Land Association: NonCalcic Brown

The surface texture is loam and the subsoil texture very gravelly clay loam. This association occurs on high terraces. The rough broken land is steep or very steep with numerous intermittent drainage channels. It has a cover of vegetation, as opposed to Badland which has sparse vegetation or complete lack of cover. This association is rated high in its ORV impact because of its highly erosive nature.

BL - Badland - San Timoteo Association: Rendzina

These areas are steep or very steep with moderately fine to fine surface textures. Geological erosion is active and the area has numerous intermittent drainage channels. Vegetation is usually very sparse. The Badlands are located on Pliocene nonmarine sedimentary rocks. This area is rated high in its ORV impact because of its highly erosive nature.

BO - Barstow-Oban-Hacienda Association: Solonetz

Surface textures vary from loamy sand to sandy loam and subsoil textures vary from sandy loam to clay loam. Soils in this assocation are rated high in ORV impact and high in erosion and siltation potential because of their susceptibility to compaction. These soils have a high concentration of sodium making them undesirable for plant growth. This association occurs on terraces, alluvial fans, and valley troughs.

BR - Bull Trail-Rough Broken Land Association: NonCalcic Brown

The surface texture is sandy loam and the subsoil texture clay loam for the Bull Trail series. It occurs on high terraces and alluvial fans. The rough broken land area has a wide range of surface textures with steep or very steep slopes and numerous intermittent drainage channels. This association is rated high in its ORV impact because of its high compactability and high erosion potential.

CH - Calvista-Hivista-Cinco Association: Lithosol-Red Desert-Regosol

Surface texture range from sandy loam to loamy sand and subsoil textures vary from loamy sand to clay loam. These soils occur on nearly level to strongly sloping uplands. These soils are moderately compacted and their erosion potential moderate. This association is considered medium in ORV impact.

CL - Crouch-La Posta-Glenbrook Association: Brunizem-Regosol-Lithosol

Surface and subsoil textures vary from sandy loam to loamy sand. The major portion of this association occurs on gently sloping to steep uplands in areas of deeply weathered granitic rocks. This association is rated as a high ORV impact area because of its high compactability causing reduced perolation rates. Erosion potential is moderate because of reduced percolation rate and moderately steep slopes.

CM - Coachella-Mecca-Indio Association: Alluvial

Surface textures range from sand to sandy loam and subsoil textures from sand to silt loam. These soils occur on nearly level to gently sloping flood plains and basins. This association is rated low in ORV impact because its sand surface makes it resistant to any compaction. Erosion and siltation potential for this association is low because of its high infiltration rates and nearly level position.

CO - Calpine Oak Glen-Mottsville Association: Brunizem-Alluvial

Surface textures range from sandy loam to loamy sand and subsoil textures range from clay loam to loamy sand. These soils occur on nearly level to moderately steep fans and low terraces. They formed in alluvium derived mostly from granitic and related rock sources. This association is considered medium in ORV impact and erosion and siltation potential.

CL - Crouch-La Posta-Glenbrook Association: Brunizem-Regosol-Lithosol

Surface and subsoil textures vary from sandy loam to loamy sand. The major portion of this association occurs on gently sloping to steep uplands in areas of deeply weathered granitic rocks. This association is rated as a high ORV impact area because of its high compactability causing reduced percolation rates. Erosion potential is moderate because or reduced percolation rate and moderately steep slopes.

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Surface textures range from sand to sandy loam and subsoil textures from sand to silt loam. These soils occur on nearly level to gently sloping flood plains and basins. This association is rated low in ORV impact because its sand surface makes it resistant to any compaction. Erosion and siltation potential for this association is low because of its high infiltration rates and nearly level position.

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Surface textures range from sandy loam to loamy sand and subsoil textures range from clay loam to loamy sand. These soils occur on nearly level to moderately steep fans and low terraces. They formed in alluvium derived mostly from grantitic and related rock sources. This association is considered medium in ORV impact and erosion and siltation potential.

CR - Cieneba-Rockland-Fallbrook Association: Lithosol-NonCalcic Brown

This association has well drained and somewhat excessively drained, undulating to steep, very shallow to moderately deep soils that have a surface layer of sandy loam and fine sandy loam on granitic rocks.

CT - Cajalco- Las Posas Association: Lithosols

These are well drained, undulating to steep, moderately deep to shallow soils that have a surface layer of fine sandy loam and loam.

DR - Duneland Association: ---

These are areas of high hills or ridges of sand sized particles drifted and piled by the wind. The majority of these dunes are on or around margins of playas and were formed from shores of old Pleistocene lakes. The high concentration of similar size sand particles makes it highly resistant to compaction and is considered low in ORV impact. The erosion and siltation potential is also low.

DT - Daggett-Toponah-Bitter Spring Association: Calcisol

Surface textures vary from gravelly sandy loam to sand and sub-soil textures vary from very gravelly sandy loam to gravelly sand. These soils occur on convex and smooth, nearly level to strongly sloping alluvial fans and terraces. These soils formed in very gravelly sandy alluvium from a variety of rocks, predominantely grantitic with some basaltic and rhyolitic materials. This association is high in ORV impact because of its susceptibility to compaction and its high erosion and siltation potential.

FE - Friant-Escondido Association: Lithosol-NonCalcic Brown

These soils are well drained and somewhat excessively drained, undulating to steep, shallow to deep soils tht have a surface layer of rocky fine sandy loam and gravelly loam on metamorphosed sandstone and mica-schist.

GR - Granite Rockland: ---

These are areas with granite rock outcrops. The soil is very shallow to none in most places. This area is considered low in ORV impact because of its high percentage of rocks and lack of soil. The erosion and siltation potential is low because of lack of soil.

HT - Hanford-Tumunga-Greenfield Association: Alluvial - Alluvial-NonCalcic Brow

These soils are very deep, well drained to excessively drained, nearly level to moderately steep soils that have a surface layer of sand to sandy loam. Such soils are found on alluvial fans and flood plains.

IH - Imperial-Holtville Association: Regosol

The surface texture of this association is clay and subsoil textures vary from clay to clay loam. Soils in this association occur on nearly level flood plains or lacustrine basins. These fine textured soils are considered high in ORV impact because of their susceptibility to compaction resulting in reduced percolation rates.

IT - Indo-Termal Association: Regosol

Surface textures range from sandy loam to clay loam and subsoil textures range from silt loam to clay loam. These soils are on nearly level flood plains and basins at elevations of 200 feet below sea level to 300 feet above sea level. The parent material consists of recent alluvium derived from a variety of rock sources and deposited by the Colorado River and other streams. This association is considered high in ORV impact because of its high compaction potential.

LR - Lava Rockland Association: ---

These are extensive areas with volcanic material. The soil is very shallow to none. This is considered a low ORV impact area and low potential for erosion and siltation because a great majority of the area is devoid of any soil and is made up of barren volcanic material.

MA - Monserate-Arlington-Exeter Association: NonCalic Brown

These soils are well drained, nearly level to moderately steep soils with a surface layer of sandy loam to loam and are shallow to deep in a hardpan.

MJ - Mariposa-Josephine-Sites Association: Laterite

Surface textures range from gravelly silt loam to loam and subsoils range from gravelly silt loam to clay. Depths vary from shallow to very deep. This association occurs on gently sloping to steep mountainous uplands. This association is considered a high ORV impact area and a high erosion area because of its high compactability and moderately steep to steep slopes.

NI - Niland-Imperial Association: Regosol

Surface textures of this association vary from gravelly sand to clay and subsoil texture is clay. These soils occur on flood plain edges or nearly level flood plains. The major portion of this association has a surface texture of gravelly sand or sand approximately 14 to 36 inches thick. This association is considered low in ORV impact and low in erosion potential because of its high resistance to compaction and high infiltration rates.

OJ - Ophir-James Canyon-Bishop Association: Humic Gley

Surface textures range from gravelly sandy loam to loam and subsoil textures vary from gravelly loamy sand to clay loam. These are poorly drained soils in stream bottoms or upland meadows. This association is high in ORV impact because its high organic matter content and high water table make it very susceptible to compaction.

RL - Rosamond-Land-Playas Association: Alluvial

Textures in this association are usually moderately fine or fine. These soils occur on the lower margins of fans, between sloping fans and basins, and playas. Slopes are nearly level to level and soils are formed in alluvium derived mostly from granitic and similar rocks. These soils are considered a low ORV impact area because of their low erosion and siltation potential.

RM - Rositas-Mecca-Meloland Association: Regosol

Surface textures range from fine sand to sandy loam and subsoil texture ranges from sand to clay. These soils are formed in sand blown from recent alluvium and nearly level lacustrine basins. These soils are considered a medium ORV impact area and have a medium erosion and siltation potential. Because of the gradation of soil particles within the surface horizon these soils can be moderately compacted.

SG - San Emigdio-Grangeville-Metz Association: NonCalcic Brown

These are very deep, poorly drained to somewhat excessively drained, nearly level to strongly sloping soils that have a surface layer of calcareous loamy sand to loam. Such soils are found on alluvial fans and flood plains.

SI - Supan-Iron Mountain Association: NonCalci Brown-Lithosol

Surface textures range from loam to sandy loam and subsoil textures range from loam to clay loam. These soils occur on sloping, plateau like areas or steep slopes and narrow divides at elevations of 1,500 to 5,000 feet. Underlying rock is andesitic and basaltic tuff-breccia or similar rock. This association is considered medium in ORV impact and erosion and siltation potential.

SS - San Andreas-San Benito Association: Brunizems-Chestnut

Soils within this association occur on mountainous slopes ranging from 30 to 75 percent. Surface soils are sandy loam in texture. As affected by the proposed Kaiparowits transmission system, little detrimental effect is expected although moderate erosion is already present.

TC - Toiyabe-Corbett-Granite Rockland Association: Lithosol-Regosol

Surface textures range from coarse sandy loam to loamy sand and subsoil textures range from loamy coarse sand to loamy sandy. These soils occur on sloping to very steep mountainous areas. The major portion of this association has soil depth that are shallow to bedrock. This association is rated high in ORV impact because of its susceptibility to compaction and its high erosion potential.

TD - Traver-Domino-Willows Association: Solonetz - Grumosol

Moderately drained to poorly drained, these saline-alkali soils occur on nearly level to gently sloping surfaces. The surface layer is a loamy fine sand to silty clay; they are moderately deep to very deep with a calcareous hardpan.

TE - Tivy-Exchequer Association: NonCalcic Brown-Lithosol

Soils of this association occur in rocky steep areas with slopes ranging from 30 to 75 percent. In general these soils exhibit moderate amounts of erosion. Such soils occur in coastal mountain areas of Orange County transected by the proposed Kaiparowits transmission line. Surface texture is generally coarse sandy loam.

TP - Thermal-Playas Association: Regosol

Textures in this association are usually moderately fine or fine. These soils occur on lacustrine basins and playas. The major portion of this association is located in areas of playas. Slopes are nearly level to level and are formed in fine and moderately fine "silty" alluvium derived from a variety of rock sources. This association is considered low in ORV impact because of its low erosion and siltation potential and low compactability.

TS - Tujunga-Soboba-Riverwash Assocation: Alluvial

Surface textures range from sand to loamy sand and subsoil textures range from sand to very gravelly sand. These soils occur on fans, flood plains and drainage ways and are formed in alluvium derived mostly from granitic sources. This association is considered low in ORV impact because of its resistance to compaction and low erosion potential.

TW - Tortugas-Winona Association: Lithosol

Surface and subsoil texture for this association is cobbly loam.

These soils occur on moderately steep to very steep mountainous areas. These soils are very shallow to bedrock. This association is considered high in ORV impact because of its high erosion and siltation potential.

VB - Vinton-Brazitos-Dune Land Association: Alluvial

Surface textures range from sand to sandy loam with the majority of the area having loamy sand textures. Subsoil textures range from sand to loamy sand. These soils occur on nearly level or very gently sloping flood plains or low terraces. This association is considered medium in ORV impact and erosion potential.

XA - Aco-Acolita-Rositas Association: Alluvial-Red Desert-Regosol

Surface and subsoil textures vary from sandy loam to sand. These soils occur on nearly level to gently sloping terraces slightly above the flood plain or low dunes or dune ridges. These soils were developed in wind-modified coarse and moderately coarse textured sediments derived from mixed sedimentary and crystalline rocks. This association is considered medium in ORV impact and erosion potential.

XC - Sheephead-Crafton Association: Lithosol-Regosol

Textures of the surface horizon range from sandy loam to loamy fine and subsoil texture is gravelly sandy loam. These soils occur on moderately sloping to very steep uplands at elevations of 2,500 to 6,000 feet. This association is considered high in ORV impact because of its susceptibility to erosion and siltation.

XO - Chuckwalla-Orita-Rough Broken Land Association: Red Desert

Surface textures range from gravelly silt loam to loamy sand and subsoil textures range from very gravelly clay loam to fine sandy loam. Some of the area has high concentrations of sodium making it undesirable for plant growth. These soils occur on old fans and terraces with nearly level to level slopes. These soils are developed in somewhat stratified alluvium derived from a wide variety of rocks. This association is considered medium in ORV impact and erosion and siltation potential.

XR - Carrizo-Riverwash Association: Alluvial

Textures of surface and subsoil range from gravelly sand to sand. These soils occur on nearly level to moderately sloping flood plains and recent alluvial fans and also drainage ways. This association is considered low in ORV impact and erosion and siltation potential because of its resistance to compaction and high infiltration rate.

FIGURE 1

Soil Interpretations

Page 1 of 3

Unit	Shrink Swell Potential	Corrosivity	Road Fill	Sand and/or Gravel	Top Soil	Absorption Fields*	Foundation Support	Sanitary Land Fill*	Local Roads and Streets	Lagoons*	Embankments*	Shallow Excavations*
1	Low	High	Good	Poor	Good	Slight	Slight	Severe	Slight	Severe	Slight	Severe
1A	High	High - uncoated steel; low for concrete	Poor	Unsuitable	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Severe
1B	Moderate	Low	Good on slopes less than 15%; Poor on slopes greater than 15%	Unsuitable	Poor	Moderate on slopes less than 15%; severe otherwise	Severe	Severe	Severe	Severe	Severe	Severe
1D	High	High to moderate for uncoated steel; low for concrete	Poor to fair	Unsuitable	Poor	Severe	Moderate to Severe	Severe	Moderate to Severe	Moderate to Severe	Moderate to Severe	Moderate to Severe
2	Low	High	Poor	Poor	Poor	Severe	Severe	Severe	Moderate	Severe	Severe	Severe
2A	Low to Moderate	Moderate to high for uncoated steel; Low for concrete	Poor	Unsuitable	Poor	Severe Bedrock 10 to 20 inches	Severe	Severe	Severe	Severe	Severe	Severe
3	Low	High	Good	Poor	Good	Slight	Slight	Severe	Slight	Severe	Slight	Slight
3A	Shoulow High; Pastura Low; Paley High	High for steel; Low for concrete	Fair to Poor	Unsuitable All	Poor All	Severe All	Shoulow & Pastura Severe; Paley Moderate	Severe All	Shoulow Severe; Pastura & Paley Moderate	Shoulow Moderate; Pastura Severe; Paley Slight	Shoulow & Paley Moderate; Pastura Severe	Severe All

*Engineering limitations (Slight, Moderate, Severe)

(continued)

FIGURE 1

Soil Interpretations

Unit	Shrink Swell Potential	Corrosivity	Road Fill	Sand and/or Gravel	Top Soil	Absorption Fields*	Foundation Support	Sanitary Land Fill*	Local Roads and Streets	Lagoons*	Embankments*	Shallow Excavations*
4	High	High	Poor	Unsuitable	Poor	Severe	Severe	Severe	Severe	Slight - Springerville; Severe - Cabezon	Moderate - Springerville; Severe - Cabezon	Severe
4A	Low	High for Uncoated steel; May be high for concrete in local areas	Poor shallow to Bedrock	Unsuitable	Poor to fair	Severe Bedrock 5 to 20 inches	Severe	Severe	Severe	Severe	Severe	Severe
4B	Low	Moderate	Fair	Unsuitable	Good	Slight	Slight	Slight	Slight	Severe	Slight-Subject to piping	Slight
4C	Low	Low	Good	Fair for sand; unsuitable for gravel	Poor sandy low water holding capacity	Slight	Moderate	Slight	Moderate	Moderate	Slight	Slight
4D		High uncoated steel; Moderate concrete	Good to Fair	Unsuitable	Poor	Slight to Severe	Slight to Severe	Slight to Severe	Slight to Severe	Moderate to Severe	Severe	Slight to Severe
5	Low	High	Fair to Good	Unsuitable	Good	Slight	Slight	Slight	Slight	Severe	Moderate	Slight
5A	TOO VARIABLE IN CHARACTERISTICS FOR VALID ESTIMATES											
6	Low	Low	Poor	Unsuitable	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Severe
7	Low	Low	Poor	Unsuitable	Poor	Severe	Severe	Severe	-do-	-do-	-do-	-do-

FIGURE 1

Soil Interpretations

Unit	Shrink Swell Potential	Corrosivity	Road Fill	Sand and/or Gravel	Top Soil	Absorption Fields*	Foundation Support	Sanitary Land Fill*	Local Roads and Streets	Lagoons*	Embankments*	Shallow Excavations*
8	Low Tortugas & Purner; Moderate Jacks	Low - Tortugas; Moderate Purner; High - Jacks	Poor All	Unsuitable All	Poor - All	Severe - All	Severe - All	Severe - All	Severe - Tortugas & Purner Moderate	Same	Same	Severe - All
9	Low	High	Poor	Poor	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Severe
10	Low for Pastura & Abra; High-Lynx	High to Moderate	Poor to Fair	Poor	Poor - Pastura Fair-Abra Good-Lynx	Moderate to Severe	Severe - Pastura Slight-Abra Moderate-Lynx	Severe - Pastura Slight-Abra Moderate Lynx	Moderate All	Severe - Pastura Moderate Abra Slight-Lynx	Severe - Pastura Slight-Abra Moderate-Lynx	Severe - Pastura Slight-Abra Moderate Lynx
11	Moderate	Moderate	Fair	Poor	Poor	Severe	Moderate	Severe - Lonti; Moderate - Balon & Lynx	Severe - Lonti; Slight - Balon Moderate - Lynx	Slight to Moderate	Moderate	Moderate
12	Low	High	Fair	Poor	Poor	Slight	Slight	Severe	Slight	Severe	Slight	Slight
13	Low Cellar High - Lehmans	Moderate Uncoated steel; low concrete	Poor	Unsuitable	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Severe
14	Low	High	Fair	Poor	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Severe
15	Moderate	Barkerville High; Gaddes Low	Fair to Poor	Unsuitable	Poor	Severe	Severe	Severe	Severe	Severe	Moderate	Severe
16	High	Moderate	Poor	Poor	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Severe
18	TOO VARIABLE IN CHARACTERISTICS FOR VALID ESTIMATES											
19	Moderate	Slight	Severe	Poor	Poor	Severe	Severe	Severe	Severe	Severe	Severe	Slight
20	Slight	Slight	Severe	Poor	Poor	Fair	Slight	Severe	Slight	Slight	Moderate	Moderate
21	Low	Low	Poor	Unsuitable	Poor	Severe	Moderate	Severe	Severe	Severe	Moderate	Severe

APPENDIX II-7

Surface Water

APPENDIX II-7

Water Resources

Kaiparowits Plateau impact area

Surface water

Data presented in Figure 1 and Illustration 1 were collected by researchers from Northern Arizona University. The data supports conclusions cited in the Water Resources section of Chapter II.

FIGURE 1

Averaged Physico-chemical Parameters for Warm Creek and Wahweap Bays. (March-May 1972) 1 of 8
(Sample numbers refer to the sites shown in the following Illustration 1)

Sample	NO_3	NO_2	$O\text{-}PO_4$	Fe	Si mg/l	O_2	Sp. Cond. (millimho)	pH	Temp. ^oC	Secchi (meters)
Warm Creek Bay										
WC 1 surface	2.13	.033	.050	.13	9.87	10.49	.813	7.75	11.7	.75
WC 1 bottom	2.22	.003	.050	.135	10.62	10.65	.853	7.70	11.5	--
WC 2 surface	1.94	.006	.050	.07	9.37	10.55	.802	7.97	11.25	3.21
WC 2	1.81	.010	.035	.045	10.125	10.74	.793	7.90	9.77	--
16.4 feet WC 2	2.00	.006	.025	.07	9.75	10.29	.784	7.80	9.8	--
32.8 feet WC 2	2.16	.004	.010	.05	9.50	9.52	.795	7.60	7.5	--
49.2 feet WC 2 bottom	2.24	.026	.055	.16	10.125	9.15	.795	7.80	9.0	--
WC 4 surface	1.87	.007	.020	.07	10.05	10.65	.793	7.93	10.7	4.64
WC 4	2.20	.005	.030	.05	10.65	10.74	.797	7.92	9.7	--
16.4 feet WC 4	2.17	.003	.045	.08	10.25	10.66	.791	7.87	8.9	--
32.8 feet WC 4	2.15	.004	.055	.06	10.25	9.73	.824	7.86	8.5	--
49.2 feet WC 4 bottom	2.42	.033	.085	.08	11.50	8.87	.853	7.70	7.9	--

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

2 of 8

Sample	NO_3	NO_2	$O\text{-}PO_4$	Fe	Si mg/l	SO_4	Cl	HCO_3	CO_3	O_2	Sp. Cond. (millimho)	pH	Temp. ^oC	Secchi (meters)
Warm Creek Bay														
WC 1 surface	.726	.028	.040	.080	5.73	200	41.3	96.0	5.55	8.37	.772	8.40	24.9	0.51
WC 1 bottom	2.43	.028	.226	.330	7.38	310	60.5	122.6	0	7.59	.882	8.10	23.5	--
WC 2 surface	1.32	.042	.040	.196	7.85	240	46.3	94.8	5.65	9.05	.883	8.53	25.1	1.91
WC 2	1.06	.026	.025	.015	7.53	275	47.5	96.2	4.85	9.12	.913	8.36	23.1	--
16.4 feet WC 2	1.79	.046	.040	.025	7.52	250	46	96.2	4.85	7.99	.896	8.20	20.06	--
32.8 feet WC 2	2.67	.287	.100	.146	7.55	260	45	122.9	0	5.45	.913	7.85	18.6	--
49.2 feet WC 2 bottom	2.90	.160	.090	.145	8.32	250	47.5	127.1	0	3.46	.905	7.56	18.25	--
WC 4 surface	1.102	.017	.036	.020	7.63	250	50	94.8	5.54	9.35	.855	8.53	25.6	3.48
WC 4	2.19	.025	.030	.046	8.20	245	46	123.1	0	9.59	.873	8.46	24.7	--
16.4 feet WC 4	2.08	.040	.020	.040	7.60	250	41.25	124	0	8.24	.887	8.33	24.3	--
32.8 feet WC 4	1.84	.079	.038	.050	8.23	240	46.5	110.2	0	7.4	.904	8.10	18.5	--
49.2 feet WC 4 bottom	3.25	.021	.040	.186	10.83	268	54.5	132.4	0	5.15	.930	7.73	14	--

(continued)

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

3 of 8

Sample	(NO_3)	(NO_2)	$(O\text{-}PO_4)$	(Fe)	Si mg/l	SO_4	Cl	HCO_3	CO_3	O_2	Sp. Cond. (millimho)	pH	Temp. °C	Secchi (meters)
Warm Creek Bay														
WC 1 surface	1.27	.019	.093	.020	9.18	300	45	108.5	.22	8.83	.944	8.20	20.5	1.06
WC 1 bottom	1.05	.141	.020	.016	9.90	320	45	95.9	12.60	8.83	.944	8.23	20.56	--
WC 2 surface	1.09	.016	.020	.013	10.18	280	45	103.4	4.20	8.94	.905	8.23	15.3	2.59
WC 2	.999	.017	.025	.040	9.41	298	44.5	102.4	5.26	8.91	.943	8.21	20.6	--
16.4 feet WC 2	1.195	.020	.033	.016	9.83	280	47.5	102.4	5.26	8.72	.950	8.21	20.63	--
32.8 feet WC 2	1.476	.053	.031	.046	9.21	300	47.5	128.1	0	6.20	.946	7.98	19.8	--
49.2 feet WC 2 bottom	1.64	.028	.065	.080	10.20	310	45	132.3	0	5.86	.948	7.95	19.26	--
WC 4 surface	1.04	.018	.042	.013	9.48	250	45	101.9	6.30	9.12	.905	8.23	20.56	4.31
WC 4	1.128	.017	.019	.010	9.48	240	45	96.4	12.82	8.97	.905	8.36	20.5	--
16.4 feet WC 4	1.165	.0236	.025	.036	9.48	230	47.5	104.0	8.4	8.94	.905	8.23	20.5	--
32.8 feet WC 4	1.52	1.510	.011	.043	9.60	230	45	117.6	0	7.24	.862	8.08	20.16	--
49.2 feet WC 4 bottom	2.64	.016	.028	.018	11.13	250	47.5	132.8	0	4.2	.948	7.78	15.1	--

(continued)

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

Sample	NO_3	NO_2	$O\text{-}PO_4$	Fe	Si mg/l	SO_4	Cl	HCO_3	CO_3	O_2	Sp. Cond. (millimho)	pH	Temp. °C	Secchi (meters)
Warm Creek Bay														
WC 1 surface	2.06	.012	.021	.033	7.65	230	45	121.5	0	11.39	--	7.90	7.56	2.17
WC 1 bottom	1.76	.695	.025	.050	7.71	260	45	125.4	0	11.41	--	7.90	7.56	--
WC 2 surface	1.77	.009	.068	.030	8.72	230	45	122.7	0	10.74	--	7.93	8.76	3.16
WC 2	2.01	.008	.025	.010	7.78	225	45	123.8	0	10.78	--	7.86	8.13	--
16.4 feet WC 2	1.91	.009	.041	.025	7.60	210	45	120.4	0	10.74	--	7.91	7.8	--
32.8 feet WC 2	1.65	.004	.010	.010	8.43	230	45	124.3	0	10.68	--	7.90	8.0	--
49.2 feet WC 2 bottom	1.94	.005	.505	.030	7.40	220	40	123.2	0	10.74	--	7.90	7.93	--
WC 4 surface	2.02	.011	.023	.026	8.15	250	45	121.5	0	10.37	--	7.80	8.6	4.09
WC 4	1.86	.010	.037	.016	9.30	230	45	128.2	0	10.34	--	7.85	8.43	--
16.4 feet WC 4	2.01	.014	.020	.046	8.06	220	45	121.5	0	10.29	--	7.86	8.5	--
32.8 feet WC 4	2.04	.010	.028	.016	9.43	250	45	124.9	0	10.30	--	7.83	8.5	--
49.2 feet WC 4 bottom	2.54	.007	.054	.060	8.53	240	45	138.8	0	10.14	--	7.86	7.6	--

(continued)

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

Sample	NO_3	NO_2	O-PO_4	Fe	Si mg/1	O_2	Sp. Cond. (millimho)	pH	Temp. ^oC	Secchi (meters)
Wahweap Bay										
Wa 11 surface	2.07	.007	0.100	.180	9.70	10.63	.826	7.98	12.3	.845
Wa 11 bottom	2.38	.006	.130	.160	9.25	10.96	.879	8.01	11.95	--
Wa 12 surface	1.67	.007	.040	.080	9.20	10.96	.791	8.00	9.8	3.16
Wa 12	2.105	.007	.015	.060	9.90	11.13	.793	8.05	9.25	--
16.4 feet Wa 12	1.95	.009	.025	.065	10.30	11.08	.793	7.93	8.65	--
32.8 feet Wa 12	1.63	.009	.030	.040	9.75	9.93	.793	7.80	7.90	--
49.2 feet Wa 12 bottom	1.90	.006	.045	.045	8.63	10.40	.829	9.95	8.5	--
Wa 14 surface	1.97	.006	.050	.030	9.13	10.98	.809	8.08	11.05	4.6
Wa 14	2.08	.008	.030	.065	8.75	11.28	.776	7.83	10.5	--
16.4 feet Wa 14	2.00	.006	.090	.030	9.125	11.08	.774	7.98	9.95	--
32.8 feet Wa 14	1.95	.007	.005	.035	9.32	10.47	.776	7.78	8.55	--
49.2 feet Wa 14 bottom	2.29	.009	.055	.085	9.63	9.94	.774	7.75	8.45	

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

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Sample	NO_3	NO_2	$O\text{-}PO_4$	Fe	Si mg/l	SO_4	Cl	HCO_3	CO_3	O_2	Sp. Cond. (millimho)	pH	Temp. °C	Secchi (meters)
Wahweap Bay														
Wa 11 surface	1.16	.020	.05	36	8.18	250	45	101.3	12.4	9.31	.824	8.60	24.1	1.02
Wa 11 bottom	1.23	.060	.04	.16	8.05	267.5	42.5	124.9	0	7.58	.826	8.42	21.4	--
Wa 12 surface	1.00	.030	.04	.05	7.05	260	47.5	101.2	14.35	9.36	.859	8.60	24.3	2.58
Wa 12	1.21	.040	.02	.06	7.94	263	44.3	107.1	7.72	9.29	.844	8.50	23.8	--
16.4 feet Wa 12	1.10	.009	.02	.06	9.18	277.5	38.0	122.1	0	8.09	.859	8.28	21.4	--
32.8 feet Wa 12	1.46	.050	.05	.07	8.63	312.5	53.0	124.5	0	6.10	.833	7.95	18.5	--
49.2 feet Wa 12 bottom	2.69	.040	0.10	.19	9.13	325	64.3	132.2	0	5.26	.879	7.82	16.5	--
Wa 14 surface	.91	.020	.02	.04	8.20	237	47.7	100.0	8.76	9.22	.846	8.48	25.0	3.52
Wa 14	.90	.001	.06	.05	7.43	240	45.0	101.5	8.41	9.47	.865	8.58	24.4	--
16.4 feet Wa 14	.79	.022	.08	.03	7.81	242.5	43.8	123.5	0	9.37	.863	8.45	21.8	--
32.8 feet Wa 14	.68	.013	.04	.07	7.31	198.0	42.5	110.6	10.04	8.87	.804	8.30	18.77	--
49.2 feet Wa 14 bottom	2.77	.030	.04	.32	10.35	240	40.0	126.4	0	5.46	.884	7.80	14.4	--

(continued)

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

Sample	NO_3	NO_2	$O\text{-}PO_4$	Fe	Si mg/l	SO_4	Cl	HCO_3	CO_3	O_2	Sp. Cond. (millimho)	pH	Temp. °C	Secchi (meters)
Wahweap Bay														
Wa 11 surface	.93	.025	.060	.08	8.40	220	47.5	103.4	4.2	9.06	.956	8.23	19.1	1.08
Wa 11 bottom	.86	.021	.080	.047	8.30	260	47.5	103.5	0	9.06	.986	8.25	19.1	--
Wa 12 surface	.96	.017	.020	.04	8.20	210	47.5	98.1	8.04	8.96	.927	8.30	19.7	3.05
Wa 12	.81	.029	.020	.04	9.02	240	47.5	99.24	7.36	8.94	.900	8.30	19.7	--
16.4 feet Wa 12	.83	.015	.020	.03	8.42	240	47.5	107.1	9.46	8.95	.939	8.22	19.7	--
32.8 feet Wa 12	.83	.021	.018	.04	8.52	220	47.5	104.4	3.16	8.78	.931	8.20	19.6	--
49.2 feet Wa 12 bottom	1.32	.013	.020	.04	8.67	220	47.5	130.2	0	6.14	.948	7.93	18.5	--
Wa 14 surface	.93	.017	.023	.033	7.90	200	45.0	98.7	8.40	9.04	.913	8.30	19.9	4.45
Wa 14	.97	.014	.045	.04	8.65	200	47.5	99.24	7.36	9.03	.939	8.28	19.9	--
16.4 feet Wa 14	.94	.016	.020	.04	8.05	210	47.5	98.74	7.36	8.99	.913	8.32	19.9	--
32.8 feet Wa 14	.97	.118	.290	.05	8.30	210	47.5	91.8	15.8	8.59	.913	8.28	19.8	--
49.2 feet Wa 14 bottom	2.01	.011	.300	.05	9.20	225	45.0	130.7	0	3.91	.939	7.80	16.1	--

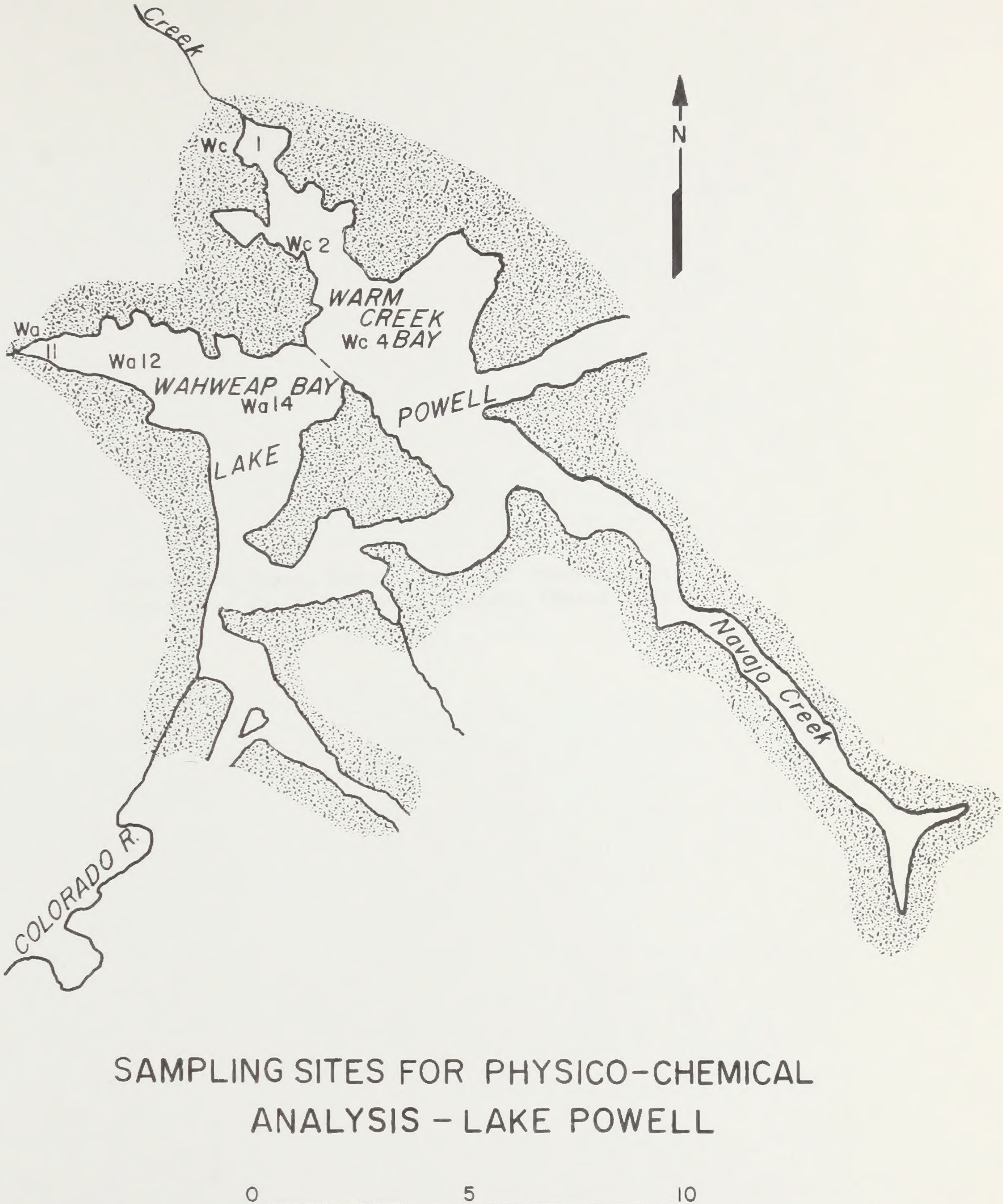
(continued)

FIGURE 1

Averaged Physico-Chemical Parameters for Warm Creek and Wahweap Bays

Sample	NO_3	NO_2	$O\text{-}PO_4$	Fe	Si mg/l	SO_4	Cl	HCO_3	CO_3	O_2	Sp. Cond. (millimho)	pH	Temp. ^oC	Secchi (meters)
Wahweap Bay														
Wa 11 surface	1.92	.015	.020	.02	7.50	230	45	125.4	0	11.39	--	7.88	7.5	1.94
Wa 11 bottom	1.58	.013	.030	.05	7.46	260	45	121.5	0	11.46	--	7.83	7.5	--
Wa 12 surface	1.69	.007	.020	.03	8.90	230	45	122.1	0	10.89	--	7.90	8.1	3.12
Wa 12	2.01	.016	.020	.02	7.93	225	45	122.1	0	10.90	--	7.85	8.1	--
16.4 feet Wa 12	1.92	.012	.030	.02	7.61	210	45	106.0	0	10.95	--	7.85	7.9	--
32.8 feet Wa 12	1.73	.009	.030	.004	8.35	230	45	122.1	0	11.00	--	7.92	7.9	--
49.2 feet Wa 12 bottom	1.92	.013	.012	.033	7.62	220	40	122.1	0	10.83	--	7.88	7.7	--
Wa 14 surface	1.96	.013	.030	.008	8.23	250	45	126.6	0	10.74	--	7.87	8.6	4.24
Wa 14	1.87	.015	.024	.03	9.38	230	45	123.8	0	10.70	--	7.83	8.3	--
16.4 feet Wa 14	1.99	.016	.027	.03	7.93	220	45	124.3	0	10.67	--	7.90	8.4	--
32.8 feet Wa 14	2.13	.008	.022	.03	7.85	250	45	125.4	0	10.61	--	7.86	8.2	--
49.2 feet Wa 14 bottom	2.14	.031	.051	.06	7.90	240	45	126.0	0	10.61	--	7.90	8.2	--

(continued)



SAMPLING SITES FOR PHYSICO-CHEMICAL ANALYSIS - LAKE POWELL

ILLUSTRATION I

APPENDIX II - 8

Vegetative Types, Description and Distribution Percentage for Kaiparowits Plateau Impact Area

APPENDIX II-8

Vegetation

Kaiparowits Plateau impact area

Vegetative types, description and distribution percentage for Kaiparowits Plateau impact area

Pinyon-Juniper Woodland - This vegetative type generally occupies higher elevations where precipitation is highest and cooler temperatures exist. Distribution: 28 percent.

Mixed Desert Shrubs - Dominated by blackbrush and spiny hopsage, this vegetative type occupied several benchlands in the study area. Distribution: 21 percent.

Salt Desert Shrubs - This vegetative type generally exists on moderate slopes and benchlands where soil is rocky and poorly drained. Salt accumulation is often apparent on the soil surface. Distribution: 12 percent.

Desert Grasslands - These grasslands are generally dominated by various combinations of pure stands of indian ricegrass, sand dropseed, blue grama and galleta grass. The soils are quite well drained and are generally deeper than soils exhibiting other vegetative types. Distribution: seven percent.

Sagebrush - Almost pure stands of sagebrush occur within the larger vegetative types. These sagebrush dominated communities most often occur on relatively level areas where alluvial deposition has occurred. Distribution: four percent.

Wasteland - This category is used to stratify all steep and rocky areas where vegetative ground cover exceeds two percent. These areas are sparsely vegetated with shallow soil and are normally not accessible for livestock use. Distribution: 25 percent.

Barren - This category is used to classify land area, which is normally completely devoid of vegetative cover. The most common land forms on which this situation occurs are rock outcrops and saline flats. Distribution: three percent.

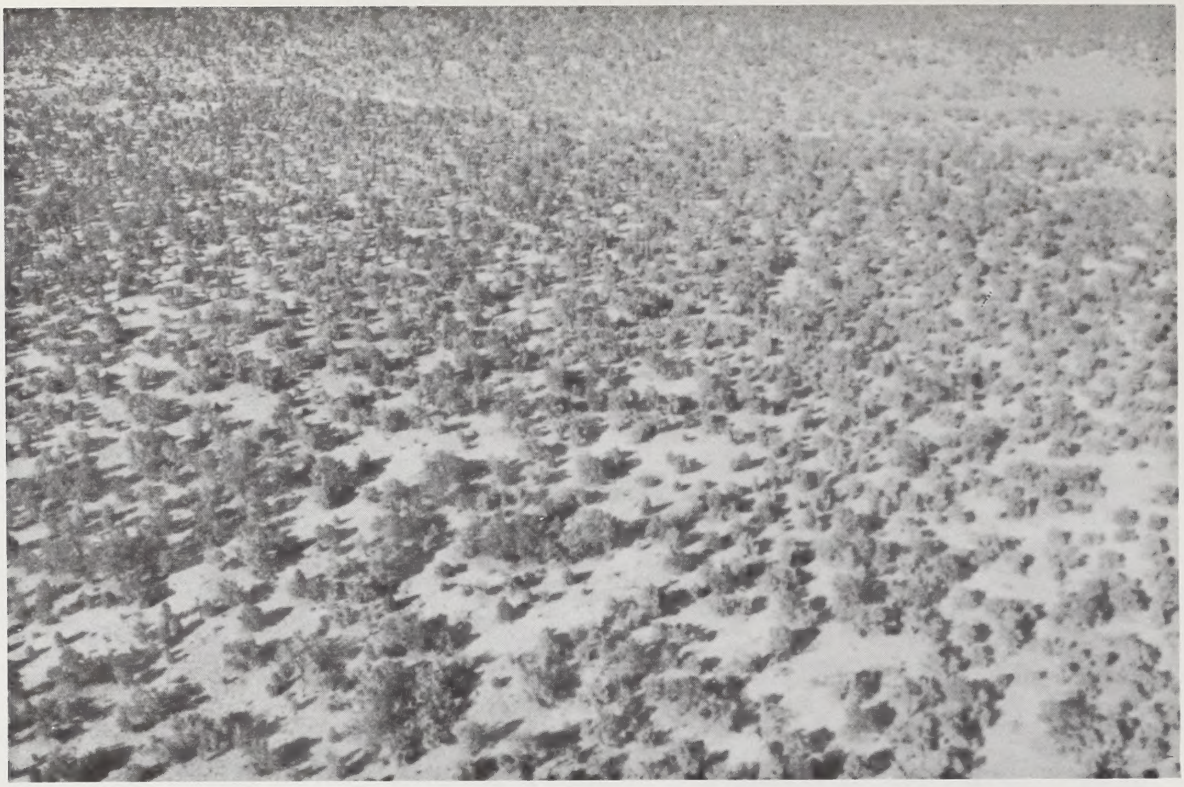
Major Vegetative Types

Barren Area (Tropic Shale Formation in middle)

ILLUSTRATION 1

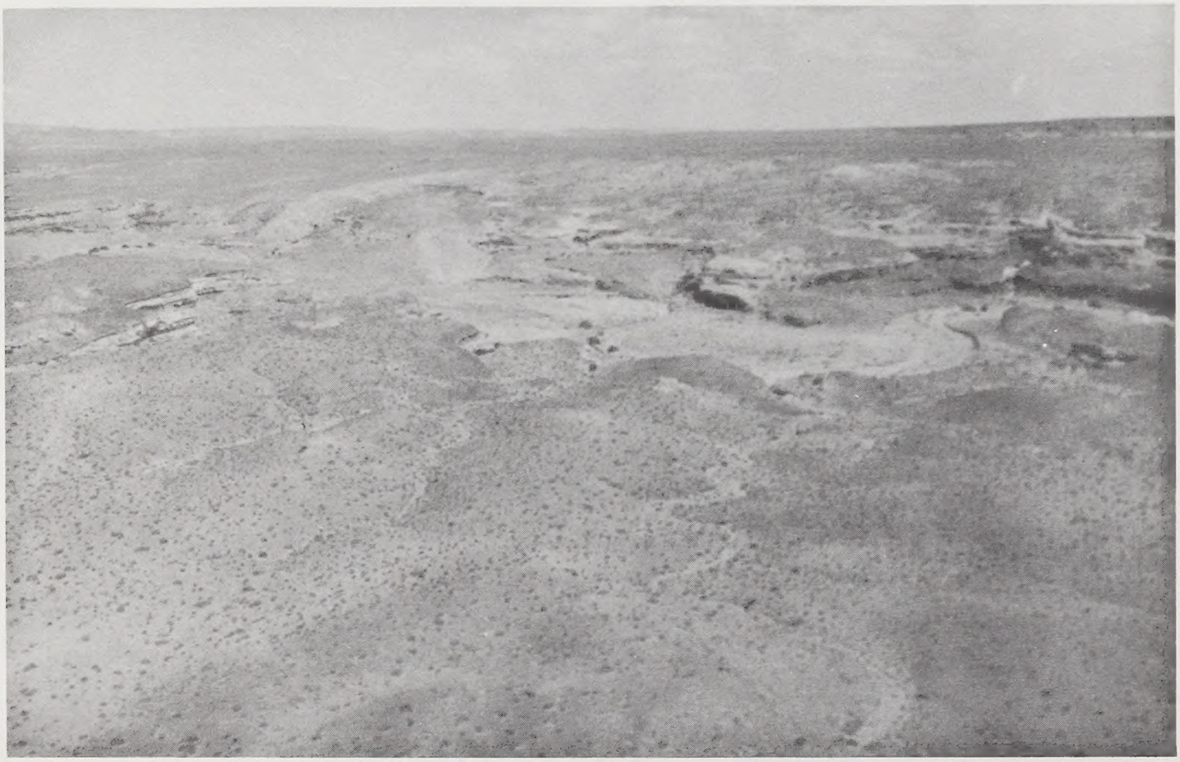
Wasteland Area

ILLUSTRATION 2



Pinyon-juniper (Sagebrush Park Upper Left)

ILLUSTRATION 3



Mixed Desert Shrub

ILLUSTRATION 4

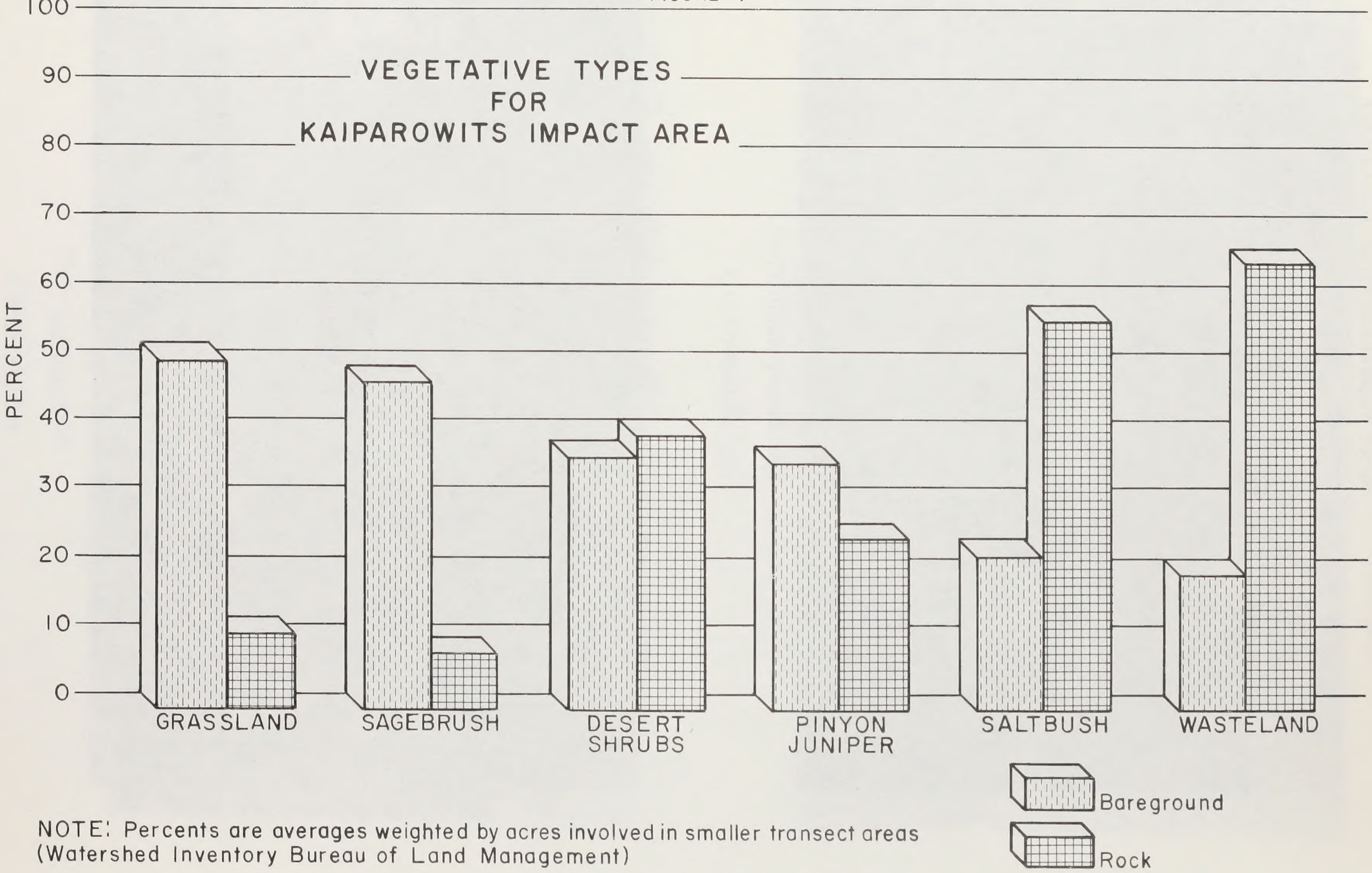
Salt Desert Shrub Type

ILLUSTRATION 5

Grassland

ILLUSTRATICN 6

FIGURE I



VEGETATIVE TYPES
FOR
KAIPAROWITS IMPACT AREA

NOTE: Percents are averages weighted by acres involved in smaller transect areas (Watershed Inventory Bureau of Land Management)

B.Y.U.
PERMANENT STUDY SITES WITHIN THE KAIPAROWITS PLATEAU IMPACT AREA

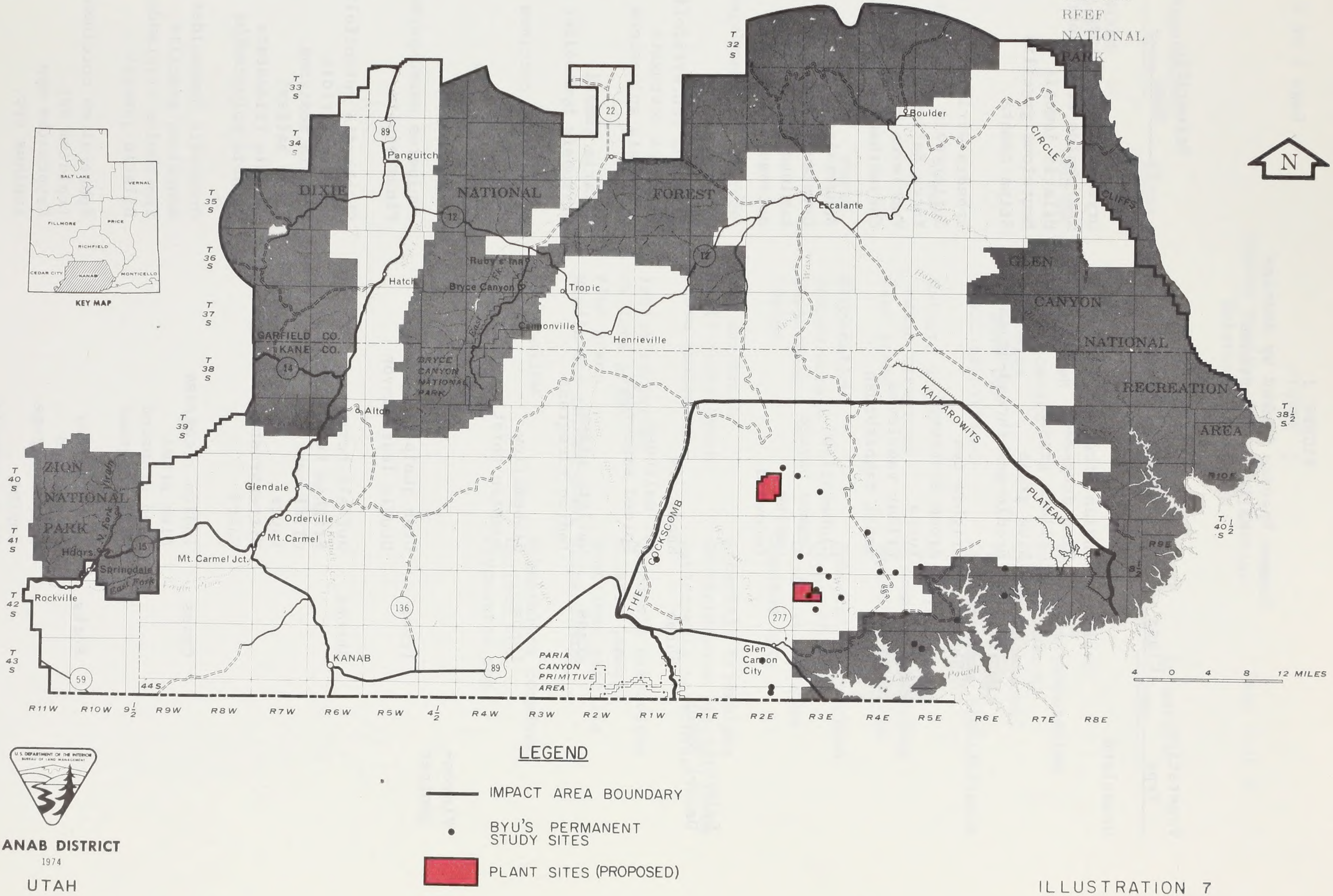


ILLUSTRATION 7

FIGURE 2

Page 1 of 2

Common Species Ranked by Average Relative Importance

Vegetation Type	Class	Common Name	Scientific Name
Grassland			
	Grass	Indian ricegrass	Oryzopsis hymenoides
		Sand dropseed	Sporobolus crypatandrus
		Galleta grass	Hilaria jamesii
		Blue grama	Bouteloua gracilis
		Needle-and-thread-grass	Stipa comata
	Shrubs	Brigham tea	Ephedra viridis
		Broom snakeweed	Gutierrezia sarothrae
		Yucca	Yucca Baileyi
		Pillar vanclevea	Vanclevea stylosa
		Small rabbitbrush	Chrysothamnus viscidiflorus
	Forbs	Globemallow	Sphaeralcea spp.
		Common borage	Cryptantha spp.
		Lupine	Lupinus pusillus
		Locoweed	Astragulus spp.
Salt Desert Shrub			
	Shrub	Shadscale	Atriplex confertifolia
		Mat saltbush	Atriplex corrugata
		Spined sagebrush	Artemisia spinescens
	grass	Galleta grass	Hilaria jamesii
		Indian ricegrass	Oryzopsis hymenoides
	forbs	Globemallow	Sphaeralcea coccinea
		Russian thistle	Salsola kali
Pinyon-juniper			
	Trees	Utah juniper	Juniperus osteosperma
		Double leaf pinyon	Pinus edulis
	Shrubs	Buffalo berry	Shepherdia rotunifolia
		Brigham tea	Ephedra viridis
		Cliffrose	Cowania mexicana
		Yucca	Yucca baileyi
		Bitterbrush	Purshia tridentata
		Cacti	Opuntia polyacantha
	Grass	Indian ricegrass	Oryzopsis hymenoides
		Blue grama	Bouteloua gracilis
		Sand dropseed	Sporobolus cryptandrus
		Galleta grass	Hilaria jamesii
	Forbs	Globe mallow	Sphaeralcea coccinea
		Pepperweed	Lepidium spp.
		Common borage	Cryptantha spp.
		Lupine	Lupinus spp.
		Misc. annuals	

(continued)

FIGURE 2

Common Species Ranked by Average Relative Importance

Vegetation Type	Class	Common Name	Scientific Name
Mixed Desert Shrub			
	Shrubs	Blackbrush	Coleogyne ramosissima
		Spiny hopsage	Grayia spinosa
		Wolfberry	Lycium andersonii
		Brigham tea	Ephedra viridis
		Small rabbitbrush	Chrysothamnus viscidiflorus
	Grass	Galleta grass	Hilaria jamesii
		Indian ricegrass	Oryzopsis hymenoides
		Blue grama	Bouteloua gracilis
	Forbs	Globemallow	Sphaeralcea coccinea
		Common borage	Cryptantha spp.
		Pepperweed	Lepidium montanum
		Lupine	Lupinus spp.
Sagebrush	Shrubs	Big sagebrush	Artemisia tridentata
		Small rabbitbrush	Chrysothamnus viscidiflorus
		Broom snakeweed	Gutierrezia sarothrae
	Grass	Indian ricegrass	Oryzopsis hymenoides
		Galleta grass	Hilaria jamesii
		Blue grama	Bouteloua gracilis
		Needle-and-thread-grass	Stipa comata
	Forbs	Globemallow	Sphaeralcea coccinea
		Lupine	Lupinus spp.
		Common borage	Cryptantha spp.
		Misc. annuals	

APPENDIX II-9

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

APPENDIX II - 9

Vegetation

Transmission system impact area

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

Biotic Community	Class	Common Name	Scientific Name
Juniper-pinyon Woodland	Grass	Blue grama	Bouteloua gracilis
		Arizona fescue	Festuca arizonica
	Forbs	Globe mallow	Sphaeralcea coccinea
		Borage	Cryptantha sp.
		Lupine	Lupinus sp.
		Pepper weed	Lepidium sp.
	Shrubs	Sagebrush	Artemisia tridentata
		Black sagebrush	Artemisia nova
		Cliff rose	Cowania mexicana
		Snakeweed	Gutierrezia sarothrae
		Algerita	Berberis fremonti
		Serviceberry	Amelanchier alnifolia
		Brigham tea	Ephedra sp.
		Bitterbrush	Purshia tridentata
	Trees	Colorado pinyon	Pinus edulis
		Utah juniper	Juniperus osteosperma
		One-seed juniper	Juniperus monosperma
		Single-leaf pinyon	Pinus monophylla
		Rocky Mountain juniper	Juniperus scopulorum
Plains and Desert Grassland	Grass	Blue grama	Bouteloua gracilis
		Black grama	Bouteloua eriopoda
		Hairy grama	Bouteloua hirsuta
		Sideoats grama	Bouteloua curtipendula
		Tobosa grass	Hilaria mutica
		Galleta grass	Hilaria jamesii
		Three awn	Aristida spp.
		Needle and thread grass	Stipa spp.
		Sand dropgrass	Sporobolus cryptandrus
		Indian ricegrass	Oryzopsis hymenoides
		Sand bluestem	Andropogon halli
		Little bluestem	Andropogon scoparius
		Love grass	Eragrostis spp.
		Bush muhly	Muhlenbergia porteria

(continued)

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

Biotic Community	Class	Common Name	Scientific Name
	Forbs	Globe mallow	Sphaeralcea spp.
		Lupine	Lupinus spp.
		Locoweed	Astragulus spp.
	Shrubs	Velvet mesquite	Prosopis juliflora
		Cat claw	Acacia greggi
		Little rabbitbrush	Chrysothamnus viscidiflorus
		Four-wing saltbush	Atriplex canescens
		Burroweed	Haplopappus spp.
		Snakeweed	Gutierrezia sarothrae
		Cane cholla	Opuntia spinosior
		Buckhorn cholla	Opuntia spp.
		Prickly pear	Opuntia spp.
		Palmilla	Yucca elata
		Sotol	Dasylirion wheeleri
Great Basin desert scrub	Grass	Galleta grass	Hilaria jamesii
		Indian ricegrass	Oryzopsis hymenoides
		Indian grass	Sorghastrum nutrans
		Salt grass	Distichilis stricta
		Blue grama	Bouteloua gracilis
		Sand dropseed	Sporobolus cryptandrus
	Forbs	Globe mallow	Sphaeralcea coccinea
		Pickle weed	Allenrolfea occidentalis
		Russian thistle	Salsola kali
	Shrubs	Sagebrush	Artemisia tridentata Artemisia nova
		Blackbrush	Coleogyne ramosissima
		Shadscale	Atriplex confertifolia
		Horse brush	Tetradymia canescens
		Winter fat	Eurotia lanata
		Mormon tea	Ephedra viridis
		Greasewood	Sarcobatus vermiculatus
		Honey mesquite	Prosopis juliflora
		Pale lycium	Lycium pallidum
Mohave desert scrub	Grass	Galleta grass	Hilaria jamesii
		Big galleta	Hilaria rigidia
	Forbs	Desert trumpet	Eriogonum inflatum
	Shrubs	Mohave yucca	Yucca mohavensis
		Banana yucca	Yucca baccata
		Brittle brush	Encelia farinosa
		Creosote bush	Larrea divaricata
		Gray Krameria	Krameria grayi

(continued)

Biotic Community	Class	Common Name	Scientific Name
	Shrubs	Cheese bush	Hymenoclea salsola
		White bursage	Ambrosia (Franseria) dumosa
		Woolly bursage	Ambrosia (Franseria) eriocentra
		Goldenhead	Acamtopappus spha erocephalus
		Bladder sage	Salazaria mexicana
		Blackbrush	Coleogyne ramosissima
		Mormon tea	Ephedra spp.
		Winterfat	Eurotia lanata
		California buckwheat	Eriogonum fasciculatum
		Mohave sage	Salvia mohavensis
		Cat claw	Acacia greggi
		Mesquite	Prosopis juliflora
		Barrel cactus	Ferocactus wislizeni
		Cholla	Opuntia spp.
		Palo verde	Cercidium floridum
		Ocotillo	Fouquieria splendens
	Trees	Joshua tree	Yucca brevifolia
Coastal sage Scrub	Grass	Mediterranean grass	Schismus barbatus
		Wild oats	Avena barbata
		Brome grass	Bromus spp.
	Forbs	Filaree	Erodium cicutarium
		Mustard	Brassica spp.
	Shrubs	California buckwheat	Eriogonum fasciculatum
		California sagebrush	Artemisia californica
		White sage	Salvia apiana
		Black sage	Salvia mellifera
		Brittle brush	Encelia farinosa
Coastal Chaparral	Grass	Wild oats	Avena barbata
	Shrubs	Chamise	Adenostoma fasciculatum
		Manzanita	Arctostaphylos spp.
		California lilac	Ceanothus spp.
		Birch-leaf mountain mahogany	Cercocarpus betuloides
		Holly-leaf cherry	Prunus ilicifolia
		Scrub oak	Quercus dumosa
		Poison oak	Rhus diversiloba
		Sugar bush	Rhus ovata
		Spanish bayonet	Yucca whipplei

(continued)

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

Biotic Community	Class	Common Name	Scientific Name
		California buckwheat	Eriogonum fasiculatum
		Brittle bush	Encelia farinosa
		Lemonade berry	Rhus integifolla
		Mustard	Brassica spp.
		Black sage	Salvia mellifera
Riparian Deciduous Woodland	Shrubs	Apache plume	Fallugia paradoxa
		Poison oak	Rhus diversiloba
		Blueberry elder	Sambucus glauca
		Oak	Quercus spp.
		Honey mesquite	Prosopis juliflora
		Cat claw	Acacia greggi
		Chokecherry	Prunus spp.
		Skunk bush	Rhus trilobata
		Tamarisk	Tamarix pentata
	Trees	Rocky Mountain maple	Acer glabrum
		Box elder	Acer negundo
		Arizona alder	Alnus oblongifolia
		Alders	Alnus spp.
		Walnut	Juglans major
		Ash	Fraxinus spp.
		Mulberry	Morus microphylla
		Sycamore	Platanus wrightii
		Narrow-leaf cottonwood	Populus angustifolia
		Fremont cottonwood	Populus fremontii
		Quaking aspen	Populus tremuloides
		Willow	Salix spp.
Interior Chaparral	Shrubs	Cliffrose	Cowania mexicana
		Apache-plume	Fallugia paradoxa
		Rosewood	Vauguelinia california
		Mountain mahogany	Cercocarpus spp.
		Buckthorn	Thamnus spp.
		Buckbrush	Ceanothus fendleri
		New Mexico locust	Robinia neomexicana
		Agave	Agave spp.
		Sotol	Nolina wheeleri
		Yucca	Yucca spp.
		Sumac	Rhus spp.
		Poison oak	Rhus diversiloba
		Red mahonia	Berberis spp.
		Brickel bush	Brickellia california
		Viscid rabbitbrush	Chrysothanmus viscidiflorus
		Turpentine brush	Haplopappus laricifolius
		Manzanita	Arctostaphylos spp.

(continued)

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

Biotic Community	Class	Common Name	Scientific Name
		Oak	Quercus spp.
		Silk-tassel	Garrya spp.
		Mountain balm	Eriodictyon angustifolium
		Feather dalea	Dalea formosa
		Wistizenius dalea	Dalea wislizeri
	Trees	Arizona cypress	Cupressus arizonica
		Arizona bark juniper	Juniperus deppeana
Sonoran Desert scrub (Arizona Upland Subdivision)	Grass	Spider grass	Aristida ternipes
		Desert fluff grass	Tridens pulchellus
		Bush muhly	Muhlenbergia porteri
	Forbs	Wild buckwheat	Eriogonum spp.
		Indian mallow	Abutilon incanum
	Shrubs	Creosote bush	Larrea divaricata
		Brittle bush	Encelia farinosa
		Navajo ephedra	Ephedra veridis
		Rabbit brush	Chrysothamnus spp.
		Prickly pear cactus	Opuntia phaeocantha
		Cactus	Echinocereus spp.
		Barrel cactus	Ferocactus spp.
		Fishhook cactus	Mammillaria microcarpus
		Cholla	Opuntia spp.
		Range ratany	Krameria grayius
		Desert thorn	Lycium andersoni
		Ocotillo	Fouquieria splendens
	Trees	Ironwood	Olneya tesota
		Saguaro	Cereus giganteus
		Foothill palo verde	Cercidium microphyllum
Sonoran Desert Scrub (Lower Colorado Subdivision)			
	Grass	Bush muhly	Muhlenbergia porteri
		Desert fluff grass	Tridens pulchellus
		Big galleta grass	Hilaria rigida
	Forbs	Quelite-salado	Suaeda torreyana
		Iodine-bush	Allenrolfea occidentalis
	Shrubs	Night-blooming cereus	Cereus greggi
		Barrel cactus	Echinocereus fendleri
		Fishhook cactus	Mammillaria fasciculata
		Staghorn cholla	Opuntia versicolor
		White bursage	Ambrosia dumosa
		Desert zinnia	Zinnia pumila
		Mormon tea	Ephedra trifurca
		Creosote bush	Larrea divaricata

(continued)

Dominant Plants of Vegetative Communities Along Proposed Transmission Line

Biotic Community	Class	Common Name	Scientific Name
Desert Wash Community	Shrubs & Trees	Cat claw	Acacia greggi
		Desert willow	Chilopsis linearis
		Desert ironwood	Olney tesota
		Smoke tree	Dalea spinosa
		Palo verde	Cercidium floridum
Alkali Sink Community	Forbs	Seapweed	Suaeda spp.
		Pickleweed	Salicornia spp.
		Iodine bush	Allenrolfea occidentalis
	Shrubs	Saltbush	Atriplex spp.
Joshua Tree Woodland	Grass	Galleta grass	Hilaria jamesii
		Big galleta grass	Hilaria rigida
		Bush muhly	Muhlenbergia porteri
	Forbs	Globe mallow	Sphaeralcea coccinea
		Filaree	Erodium cicutariun
	Shrubs	Creosote bush	Larrea divaricata
		White bursage	Ambrosia dumosa
		Yucca	Yucca schidigera
		Mohave yucca	Yucca mohavensis
		Cheese bush	Hymenoclea salsola
		Bladder sage	Salazaria mexicana
	Trees	Joshua tree	Yucca brevifolia

APPENDIX II-10

Vegetative Communities

APPENDIX II - 10

Vegetation

Transmission system impact area

Vegetative communities

Pinyon-juniper woodland

Juniper (cedar) is more prevalent along this section than pinyon pine. It reaches its greatest development on plateaus and mesas at elevations between 5,500 and 7,500 feet. Below 6,000 feet the woodland is often characterized by juniper in pure stands. This woodland occurs on highly varied soils, from rocky to sandy and shallow to deep. Junipers have extended widely into former range grasslands during the past 100 years. The juniper to pinyon ratio is about three to two in this vegetative community. Colorado pinyon (Pinus edulis) is the common and characteristic pinyon species. Singleleaf pinyon (Pinus monophylla) occurs locally with Utah juniper. Utah juniper (Juniperus osteosperma) and one-seed juniper (Juniperus monosperma) are the common and widespread juniper species.

The understory is either grassland or desert scrub. Grasses were historically more abundant. Many weed and shrub plants have replaced grasses in the understory where overgrazing has been severe.

Great Basin Desert scrub

This shrub-dominated and relatively simple structured desert scrub of the Great Basin "cold desert" is characterized by low plant species diversity, many of which are specialized for salt and cold tolerance. Several of the plant dominants such as sagebrush (Artemisia tridentata), blackbrush (Coleogyne ramosissima) and shadscale (Atriplex confertifolia) occur in essentially pure shrub stands. This type grows between 3,000 and 6,500 feet elevation, with most of it above 4,000 feet.

Mohave Desert Scrub

This type is situated for ecological reasons between the colder Great Basin desert scrub on the north and the warmer Sonoran desert scrub on the south. Mohave desert scrub is found between approximately 800 and 5,200 feet, mostly between 1,000 and 4,000 feet. High aridity with relative lack of summer rains, and long periods of below freezing winter temperatures combine to make the Mohave Desert poor in plant life.

Creosote bush (Larrea divaricata) and white bursage, (Ambrosia dumosa) dominate extensive areas. Bladder sage (Salazaria mexicana) is a prominent shrub that is almost wholly confined to this type. Mohave sage (Salvia mohavensis) and wooly bursage (Ambrosia eriocentra) are near-endemic shrubby species in the Mohave desert scrub community. The Joshua tree (Yucca brevifolia) is an endemic tree yucca that forms extensive "forests" or "woodlands" associated with various shrubby species such as creosote bush, bladder sage, goldenhead (Acamptopappus sphaerocephalus), winter-fat (Eurotia lanata) and black brush. Mohave yucca (Yucca mohavensis) and banana yucca (Yucca baccata) are interspersed with Joshua trees. Cat claw (Acacia greggi) and mesquite (Prosopis juliflora) are found in the washes. For purposes of this statement, the Joshua tree woodland association has been separated from this community and is discussed as a separate community.

The creosote bush scrub association covers most of the California deserts. It is composed of low growing shrubs one to five feet tall. Areas with low moisture have sparse vegetation and are often composed solely of creosote bush and occasional annuals. Areas of higher moisture often contain large amounts of blackbrush. The creosote bush-cheese bush (Hymemoclea salsola) association is the dominant vegetation of Mohave desert scrub communities along the proposed powerline route.

The octotillo (Fouqieria splendens)-palo verde (cericidium floridum) - Cat claw association is uncommon to the Mohave desert scrub community and is confined to a few more arid areas.

Desert wash association

The desert wash association is found along washes and dry stream beds throughout the desert. Water supply is adequate to support this vegetation. In some areas, the vegetation is sparse and stunted. In other areas, the vegetation is dense with palo verde, smoke trees (*Dalea spinosa*) and desert ironwood trees (*Olneya tesota*) reaching 10 to 20 feet high.

Alkaline sink vegetative association

Alkaline sink vegetation is restricted to low spots where water collects and evaporates, leaving high concentrations of salts. These plants are adapted to alkaline soils. Vegetation is extremely sparse with large amounts of exposed soil.

Plains and desert grassland

This grassland type is unique because grasses are comingled with various woody shrubs. Lower elevational limit of the desert grassland transition is about 3,500 feet, and it ordinarily prevails to approximately 5,000 feet. It occurs on the desert in local areas where soil-type factors increase the plant-available soil moisture. Thus, it can exist in areas which receive as little as six to seven inches average annual precipitation, which is well below the ordinary lower limit of 10 to 11 inches for desert grassland.

Coastal sage scrub

Coastal sage scrub is an open shrub community, with shrubs reaching five feet in height but infrequently growing together to form a closed canopy. Open areas are covered by forbs and grasses, leaving little bare ground. This plant community is found at elevations below the more dense chaparral. In recent years, much clearing has taken place. It has been subject to grazing and is now becoming dominated by introduced grasses and forbs. The amount of coastal sage scrub in southern California has dwindled in the last 50 years due to the ease with which it can be cleared. Agricultural and urban growth has extended into these areas.

Coastal chaparral

This chaparral plant community is composed of evergreen shrubs three to 10 feet high. Vegetation is usually very dense and often difficult to walk through. Only at the edges or in places where the canopy opens and allows light to reach the soil are high densities of forbs and grasses found. Prior to man's fire prevention practices, chaparral was subject to burning every 20 to 40 years. Plants have adapted and if regular burning does not occur, succession to an oak woodland type will take place where soil and moisture conditions are proper. Burning is necessary to maintain chaparral in its prime condition. Modern management practices use chaining and other clearing methods in place of fire.

Chamise chaparral is intermediate between coastal sage scrub and chaparral is open in some areas and very dense in others. Fire is an important factor in its ecology as in chaparral. Chamise chaparral is decreasing in abundance due to the ease with which it can be cleared for agricultural and urban uses. This chaparral type has been incorporated into the coastal chaparral community.

Interior chaparral

Interior chaparral occurs in the central part of Arizona, usually between 4,000 and 6,000 feet, and as high as 7,000 feet. Precipitation ranges from approximately 13 to 23 inches annually. Chaparral in Arizona is characterized by dense shrubby growth and fairly uniform heights between three and six or seven feet, broken by an occasional taller pinyon, juniper or Arizona cypress (*Cypressus arizonica*).

The dominant plants are generally tough-leaved, evergreen shrubs. Scrub oak is by far the most common dominant, accounting for over 90 percent of the stand in many areas. Several dozen other shrubby plant species are typically found in mature stands of chaparral, such as buckthorn (Thamnus spp.), mountain-mahogany (Cerocarpus spp.), manzanita (Arctostaphylos spp.), yucca, some juniper, oak (Quercus spp.) and cactus (Opuntia) species.

Density and distribution of grasses in Arizona chaparral are governed by shrub density; the more dense the chaparral, the fewer grasses.

Pockets of Encinal oak-pine woodland occur through the interior chaparral biome as far north as the Mogollon Rim. They are not extensive enough to be identified as a separate biome in the study area; however, species such as Emory (Quercus emoryi), Mexican blue (Q. oblongifolia), Arizona (Q. oblongifolia) , Arizona (Q. arizonica) and gray (Q. grisea) oaks, alligator (Juniperus deppenana) and other junipers, a small stand of Arizona cypress and shrubs common to the oak-woodland biome can be found.

Sonoran desert scrub

Sonoran desert scrub extends for many unbroken miles across Arizona. In the southern part of the state the proposed transmission line crosses two major desert scrub biotic communities: the shrub-form palo verde-saguaro or palo verde-cactus communities (Arizona upland subdivision). Also involved may be the more restricted saltbush desert thorn community found within the lower Colorado subdivision.

Desert scrub found in the study area and along the proposed route tends to be reasonably stable under the existing climate. The environment is especially harsh; species makeup is exclusive, and the same species are both pioneer and climax plants in the desert scrub non-succession. Thus, Sonoran desert scrub, in most areas, is the least sensitive community to be crossed by the powerline.

Sonoran desert scrub (Arizona upland)

Palo verde-saguro (Cereus giganteus) or palo verde-cactus community is characteristic of the Arizona upland subdivision. It is the most lush and most diverse desert community in the United States, often containing more than 100 native desert plants in any one of the various local habitats. This figure may be compared to a similar size area in the creosote bush or saltbush desert communities where three or four species are typically found.

Typical plants in palo verde-saguaro are foothill palo verde (Cercidum microphyllum), saguaro, and numerous species of smaller cacti. Desert thorn (Lycium andersoni), Indian mallow (Abutilon incanum), ocotillo, ironwood, brittlebush (Encelia furinosa), and bush muhly (Muhlenbergia porteri) are also commonly encountered. In addition to the above perennials. Many species of small annuals may be added which bloom only after summer rains. The best developed palo verde-saguaro stands are generally restricted to small concentrated areas.

Sonoran desert scrub (lower Colorado)

Vegetation of this major subdivision of the Sonoran desert is dominated by creosote bush and its major associate, white bursage. In local situations such as river flood plains and low undrained areas within valleys and basins, communities of saltbush, desert thorn and mesquite commonly dominate, often to the total exclusion of creosote bush and bursage.

Both creosote bush-bursage and salt bush desert thorn communities have few species, at least in comparison with others thus far discussed. Roughly ten species, such as creosote bush, white bursage, and several species of cacti, may be found in the former, while only six are characteristic of the latter.

In addition to the above desert communities, another quite different plant assemblage may be found growing along arroyos and large washes in the desert. These desert "riparian" species include white thron, cat claw, mesquite, and occasionally blue palo verde. These species, in association with several other small shrubs, often form a distinct fingerlike riparian association well into the desert where elements of the riparian woodland fail to penetrate. Under very dry conditions, in areas receiving less than six inches of rainfall, even the upland climax dominants such as saguaros and palo verdes may be found more or less restricted to such riparian habitats.

Riparian deciduous woodland

Riparian woodlands occur along perennial and intermittent streams and rivers. Quality of this type of vegetation depends heavily upon water availability. Where water is readily available year-round, riparian growth may be very dense. Where only intermittent water is available, riparian woodlands tend to be less well developed and may, in fact, be dominated by vegetation more characteristic of surrounding areas.

These are very sensitive communities, restrictive as to area and remnants of earlier widespread forests. This biome has definite plant successional stages (steps to a stable condition), and these present communities are generally in their climax, or final state. If disturbed, it would take a number of years, if ever, before the area would return to the same condition.

Species composition of riparian woodlands changes with altitude and location. On the Colorado Plateau, in the vicinity of the Little Colorado River, Fremont cottonwood (Populus fremontii) and willow (Salix spp.) are dominant. Characteristics of this area are governed by Great Basin desert scrub and grassland with elements of both communities commonly found close to waterways vegetation.

Riparian communities

In areas of springs, seeps, washes and marshes, typical vegetation consists of rushes, bullrushes, copperweed, and rabbitsfoot grass. The sediment bars along major channels support luxuriant vegetation such as skunkbush (Rhus trilobata), Apache plume (Fallugia paradoxa), and tamarisk (Tamarix pentata).

Joshua tree woodland

This community was taken out of the Mohave desert scrub community as described by Lowe and Brown in "The Natural Vegetation of Arizona," and is treated as a separate community. Joshua trees are dense in some areas and have the appearance of a woodland type. In other areas they are scattered and are classed in the Mohave desert scrub community.

Most of this community lies between 2,500 and 4,000 feet elevation. Annual precipitation varies between eight and 11 inches. Vegetation is similar to the higher elevations of the Mohave desert scrub type described above.

Urban agricultural

These are lands that are presently being used or developed for agriculture or expansion of urban areas. Small areas of undisturbed coastal sage and coastal chaparral are found within this description.

Besides the biotic communities listed above, there are two categories of rangeland that warrant discussion. They are wasteland and barren ground. The wasteland category is used to classify all steep and rocky areas where vegetative ground cover still exceeds two percent. It usually consists of shallow soils that are very sparsely vegetated. The barren category is used to identify rangeland which contains less than two percent vegetative ground cover. This type often occurs as rock outcrops and saline flats. These types are usually small local areas and are not delineated on the map.

APPENDIX II-11

Birds of Prey and Vultures of the Kaiparowits Plateau

APPENDIX II - 11

Wildlife

Birds of Prey and Vultures of the Kaiparowits Plateau*

* Includes species outside of plant-mine site impact area but within the larger area of secondary project influence.

COMMON NAME	SCIENTIFIC NAME
Hawks	
goshawk	Accipiter gentilis
sharp-shinned hawk	Accipiter striatus
Cooper's hawk	Accipiter cooperii
red-tailed hawk	Buteo jamaicensis
red-shouldered hawk	Buteo lineatus
Swainson's hawk	Buteo swainsoni
rough-legged hawk	Buteo lagopus
ferruginous hawk	Buteo regalis
golden eagle	Aquila chrysaetos
bald eagle	Haliaeetus leucocephalus
marsh hawk	Circus cyaneus
prairie falcon	Falco mexicanus
peregrine falcon	Falco peregrinus
merlin (pigeon hawk)	Falco columbarius
kestrel (sparrow hawk)	Falco sparverius
Vultures	
turkey vulture	Cathartes aura
Owls	
screech owl	Otus asio
flammulated owl	Otus flammeolus
great horned owl	Bubo virginianus
pygmy owl	Glaucidium gnoma
burrowing owl	Speotyto cunicularia
spotted owl	Strix occidentalis
long-eared owl	Asio otus
short-eared owl	Asio flammeus
saw-whet owl	Aegolius acadicus
barn owl	Tyto alba

APPENDIX II-12

Checklist of Birds of the Kaiparowits Basin

APPENDIX II - 12

Wildlife

Checklist of Birds of the Kaiparowits Plateau*

* List includes species found outside of plant-mine site impact area but within the larger area of secondary influence. A few species recorded along the Colorado River before inundation by Lake Powell may no longer be present.

P -- Permanent resident

S -- Summer resident

W -- Winter resident

T -- Transient or migrant

F = Recent Field Studies - (since 1964 when Lake Powell began filling)

L = Literature Review - studies before Lake Powell

COMMON NAME	Habitat Type							
	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Loons								
common loon	T	L						
Grebes								
eared grebe	T	F						
western grebe	T	F						
pied-billed grebe	T	F						
Pelicans								
white pelican	T	L						
Cormorants								
double-crested cormorant	T	L						
Herons and Bitterns								
great blue heron	ST			F				
great egret	W			F				
snowy egret	T			L				
black-crowned night heron	T			L				
American bittern	T			L				

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Seasonal Occurrence	Habitat Type Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Ibises and Spoonbills								
white-faced ibis	T	L						
Swans, Geese, and Ducks								
Canada goose	T	F						
snow goose	T	L						
mallard	WT	F						
gadwall	WT	F						
pintail	WT	L						
green-winged teal	WT	L						
blue-winged teal	T	L						
cinnamon teal	T	F						
American widgeon	T	L						
shoveler	T	L						
ring-necked duck	T	F						
canvasback	WT	L						
lesser scaup	W	L						
common goldeneye	T	F						
bufflehead	T	F						
ruddy duck	T	L						
common merganser	WT	L						
American Vultures								
turkey vulture	S		F			F		
Birds of Prey								
goshawk	S			F				
sharp-shinned hawk	P		F					F
Cooper's hawk	P		F					F
red-tailed hawk	P		F					F
Swainsons's hawk	S		F			F		
ferruginous hawk	P		F			F		
golden eagle	P		F					F
bald eagle	W	F		F	F			
marsh hawk	P	F					F	

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Seasonal Occurrence	Habitat Type Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Birds of Prey (continued)								
prairie falcon	P		F					F
peregrine falcon	ST				F		F	F
merlin (pigeon hawk)	WT		F		F		F	
American kestrel (sparrow hawk)	P		F					F
screech owl	P			L				
flammulated owl							L	L
great horned owl	P			F	F			
pygmy owl	P						L	
burrowing owl	S					L		
spotted owl	P			F			F	F
long-eared owl	P			L				
short-eared owl		L		L		L		
saw-whet owl				L				
Grouse								
blue grouse	P							L
sage grouse	P							L
Quails and Pheasants								
Gambels quail	P		F					F
chukar	P		F			F		
Turkeys								
turkey	P							F
Rails, Gallinules, and Coots								
Virginia rail	T	L						
sora rail	T	L						
yellow rail	T	F						
American coot	ST	F						

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Seasonal Occurrence	Habitat Type Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Plovers								
killdeer	P	F		F				
Snipe and Sandpipers								
common snipe	T	L						
long-billed curlew	T			L				
spotted sandpiper	T	L		L				
solitary sandpiper	T			L				
willet	T			L				
greater yellowlegs	T			L				
lesser yellowlegs	T			L				
Baird's sandpiper	T			L				
least sandpiper	T			L				
long-billed dowitcher	T			L				
western sandpiper	T			L				
Avocets and Stilts								
American avocet	T			L				
Phalaropes								
red phalarope	T							
Wilson's phalarope	T	F		F				
northern phalarope	T	F						
Gulls and Terns								
California gull	T			F				
ring-billed gull	T			L				
Franklin's gull	T			L				
Bonaparte's gull	T			L				
Forster's tern	T	L						
black tern	T			L				

(continued)

COMMON NAME	Habitat Type							
	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Pigeons and Doves								
band-tailed pigeon	S						F	
mourning dove	S		F		F		F	F
Cuckoos and Roadrunners								
yellow-billed cuckoo	S			L				
roadrunner	P					L		
Goatsuckers								
poor-will	S			F		F		
common nighthawk	S					F	F	
Swifts								
white-throated swift	S					F	F	
Hummingbirds								
black-chinned hummingbird	S			F		L		
Costa's hummingbird	S							
broad-tailed hummingbird	S		L					L
rufous hummingbird	T		L					L
Allen's hummingbird	T							
calliope hummingbird	T			L		L		
Kingfishers								
belted kingfisher	T	L		L				
Woodpeckers								
common flicker	P		F	F	F			F
Lewis' woodpecker	S							F
yellow-bellied sapsucker	P			F				F
Williamson's sapsucker	ST			L				L
hairy woodpecker	P			L			L	L
downy woodpecker				L			L	L

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Habitat Type							
	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Tyrant Flycatchers								
eastern kingbird			L					
western kingbird	S			F				
Cassin's kingbird	S			L				
ash-throated flycatcher	S			L			L	
black phoebe	P			L		L		
Say's phoebe	S					F		
Traill's flycatcher	S			L		L		
dusky flycatcher	S			L				
gray flycatcher	ST			L				
western flycatcher				L			L	L
western wood pewee	ST			F			F	F
olive sided flycatcher	ST	F		L			L	L
Larks								
horned lark	P		F			F		
Swallows								
violet-green swallow	S	F	F	F	F	F	F	F
tree swallow	T			L				
bank swallow	T			L				
rough-winged swallow	ST			F				
barn swallow	T			L				
cliff swallow	S				L			
Jays, magpies, and crows								
Steller's jay	P						L	L
scrub jay	P					F	F	
common raven	P		F	F	F	F	F	F
common crow	T		F	F	F	F	F	F
pinyon jay	P						F	
Clark's nutcracker	P						F	F

(continued)

Checklist of Birds of the Kaiparowits Plateau

COMMON NAME	Habitat Type							
	Seasonal Occurrence	Marsh & Open Water	Grassland Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Titmice, Verdins, and Bushtits								
black-capped chickadee	W			L			L	L
mountain chickadee	P			F			F	F
plain titmouse	P						F	
bushtit	P			F			F	F
Nuthatches								
white-breasted nuthatch	P						L	L
red-breasted nuthatch	P						L	L
pygmy nuthatch	P						L	L
Creepers								
brown creeper	P						L	L
Dippers								
dipper	P	L		L				
Wrens								
house wren	P						L	L
Brewick's wren	P			L		L	L	
long-billed marsh wren	T	L		F	F			F
canyon wren	P			F	F			F
rock wren	S				F	F	F	F
Mockingbirds and Thrashers								
mockingbird	P		F			F	F	
grey catbird	ST			F		F		
Bendire's thrasher								
sage thrasher	S		F			F		

(continued)

COMMON NAME	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Thrushes, Solitaires, & Bluebirds								
American robin	P			F			F	F
hermit thrush	ST			F			F	F
Swainson's thrush	T			F				F
western bluebird	PT			F		F	F	F
mountain bluebird	PT					F	F	F
Townsend's solitaire	P			L	L			L
Old World Warblers, Gnatcatchers, and Kinglets								
blue-gray gnatcatcher	S			F		F	F	F
golden-crowned kinglet	W			F			F	F
ruby-crowned kinglet	P			F			F	F
Wagtails and Pipits								
water pipit	WT					L		
Waxwings								
Bohemian waxwing	W						F	
Silky Flycatchers								
phainopepla	S			L		L		
Shrikes								
northern shrike	W					L		
Loggerhead shrike	P						F	F
Starlings								
starling	P		F	F	F	F	F	F

(continued)

COMMON NAME	Habitat Type							
	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Vireos								
solitary vireo	ST			F				F
warbling vireo	ST			L				L
Wood Warblers								
orange-crowned warbler	T			L				
Nashville warbler	T			L				L
Virginia's warbler	T			F				F
Lucy's warbler	S			L				
yellow warbler	ST			L				L
yellow rumped warbler	ST			F			F	F
black-throated gray warbler	S						F	
Townsend's warbler	T			L				L
hermit warbler	T							L
Grace's warbler	S						F	F
northern waterthrush	T			L				
MacGillivray's warbler	T			F				
yellowthroat	S	L		L				
yellow-breasted chat	S			L				
Wilson's warbler	T			L				L
Weaver Finches								
house sparrow	P							F
Meadowlarks, Blackbirds, Orioles								
bobolink	T			L				
western meadowlark			F			F		
yellow-headed blackbird	T			L				
redwinged blackbird				L				
Scott's oriole	S			L		L	L	
northern oriole	S			L				
Brewer's blackbird	T		L	L		L		
brown-headed cowbird	ST			F		F	F	F

(continued)

COMMON NAME	Habitat Type							
	Seasonal Occurrence	Marsh & Open Water	Grassland	Riparian	Cliff & Canyon	Desert Shrub	Pinyon - Juniper	Habitats Outside Impact Area
Grosbeaks, Finches, Sparrows, and Buntings								
black-headed grosbeak	ST			F		F	F	F
blue grosbeak	S			F		F		
lazuli bunting	ST		F		F	F	F	F
evening grosbeak	T							F
Cassin's finch	ST			F				F
house finch	P			F	F	F	F	
black rosy finch	W		F			F		
pine siskin				F			F	F
American goldfinch	P			F		F		
lesser goldfinch	P			F			F	F
red crossbill	T						L	L
green-tailed towhee	T			F	F	F		F
rufous-sided towhee	P			L			L	L
lark bunting	T		F		F			
Savannah sparrow	ST		L	L		L	L	
vesper sparrow	ST		F	F		F	F	F
lark sparrow	S		F		F		F	
black-throated sparrow	S		F	F		F		
sage sparrow	P		F	F		F		
slate-colored junco	W			F				
dark eyed junco	ST,W			F			F	F
tree sparrow	W		F	F				
chipping sparrow	S					L	L	L
Brewer's sparrow	S		F			F	F	
Harris' sparrow	W		L	L		L		
white-crowned sparrow	WT		F	F		F		
Lincoln's sparrow	T			L				
song sparrow	W			F				
McCown's longspur	W		F					
chestnut-collared longspur	W		F					

(continued)

APPENDIX II - 13

Birds Observed in Immediate Vicinity of Fourmile Bench

APPENDIX II - 13

Wildlife

Birds Observed in Immediate Vicinity of Fourmile Bench

- bluebirds, mountain
- dove, mourning
- finch, house
- flicker, common
- flycatcher, ash-throated
- gnatcatcher, blue-gray
- hawk, red-tailed
- American kestrel (hawk, sparrow)
- hummingbird, ruby-throated
- jay, pinyon
- lark, horned
- mockingbird
- nighthawk
- oriole, Scott's
- owl, great horned
- shrike, loggerhead
- sparrow, black-throated
- sparrow, chipping
- sparrow, Brewer's
- sparrow, sage
- swallow, violet-green
- swift, white-throated
- vireo, grey

APPENDIX II-14

Invertebrates of Kaiparowits Plateau

APPENDIX II - 14

Wildlife

Invertebrates of Kaiparowits Plateau

DATA CODE KEY

Area

A - Lee's Ferry
B - Tibbet Springs
C - Nipple Springs
D - Lake Powell Shore
E - Page
F - Wahweap Creek
G - Navajo Mountain
H - Cottonwood Canyon
J - Waterline
k - Tibbet Canyon
L - Gypsumweed Pond
M - Powerline

Major Habitat Type

I - Shrub steppe
II - Grassland
III - Juniper woodland
IV - Coniferous forest
V - Aquatic
VI - Tamarisk

Life Stage

a - adult
n - nymph
1 - larvae
d - dead*

Where Found in Habitat

1 - Cow chip
2 - Under rock
3 - On plant
4 - Water trough
5 - Pond
6 - Seep
7 - Litter
8 - Inside Plant
9 - On soil substrate
10 - On shoreline
11 - Log
12 - Carrion
13 - Man-made structure
14 - Moss
15 - In flight

INSECTA (Class)

HEMIPTERA (Order).....Bugs

Veliidae (Family)
Velia sp. CV6a

Gerridae (Family).....Water Striders
Gerris remigis CV6a

Salididae (Family).....Shore Bugs DI10a, DI11a, EI10n, DV5a, EI3a, DI3a, HI3a

Miridae (Family).....Leaf Bugs or Plant Bugs
Numerous species collected, not yet identified AVI3a, EI10n, HI3n, HI3a

Corixidae (Family).....Water Boatmen
Hesperocorixa vulgaris EV5n
Hesperocorixa laevigata CV6a, BV6a
Graptocorixa abdominalis EV5a, EV4a
Corisella inscripta EV5a, DV5n, EV4a

Cydnidae (Family).....Burrowing Bugs MI2d, MI8d

Notonectidae (Family).....Back Swimmers
Notonecta kirbyi EV4a, BV6a
Notonecta undulata BV6a

Scutelleridae (Family).....Shield-Backed Bugs MI8d

Lygaedae (Family)
spp. unidentified AVI9a
Geocoris sp. EI9n, EI9a, EI3s

HYMENOPTERA (Order).....Bees and Wasps

Formicidae (Family).....Ants
Numerous species collected, not yet identified AVI3a, GIV7a, EI1a, FI9a, GIV7a, HI9a, AVI2a, DI9a, EI9a, MI1d, JI1d, JI2d

Pteromalidae (Family).....Parasitic Wasps HI3a

Ceraphronidae (Family).....Hyperparasitic Wasps EI3a

Halictidae (Family).....Mining Bees FI9a, HI3a

Mymeridae (Family).....Fairy Flies AVI7a

HOMOPTERA (Order)

Cicadellidae (Family).....Leafhoppers EI3a, AVI3a, DI3a

Aphididae (Family).....Plant Lice or Aphids BI5a, AVI3a, EI3a

Coccidae (Family).....Scale Insects AVI7n

Fulgoridae (Family).....Planthoppers AVI2n

Psyllidae (Family).....Jumping Plant Lice
Pachypsylla ap. MI8a

NEUROPTERA (Order)

Hemerobiidae (Family) EI4d

ORTHOPTERA (Order)

Gryllidae (Family).....Crickets

Nemobilnae (Subfamily)
Nemobius sp. AVI2a, EI2a

Acrididae (Family).....Shorthorned Grasshoppers

Acridinae (Subfamily) EI2a

Oedipodinae (Subfamily) EI2a

Blattidae (Family).....Cockroaches
Arenivagia sp. BI7a

Gryllacridae (Family)

Stenopelmatinae (Subfamily).....Gerusalem Cricket GIV9d

COLEOPTERA (Order)

Chrysomelidae (Family).....Leaf Beetles
Orsodacne sp. HI3a

Nitidulidae (Family).....Sap Beetles MI12a

Cleridae (Family)
Necrobia rufipes.....Red Legged Ham Beetle MI12a

Staphylinidae (Family).....Rove Beetles
Dianous sp. HI3a, DI2a, MI1d
Trichophys sp. EI2a
Hybrocerus sp. DI2a

COLEOPTERA (cont'd)

Aleocharinae (Subfamily) DV5a

Hydrophilidae (Family).....Water Scavenger Beetles
Enochrus sp. KV6a, BV6a
Laccobius sp. BV6a, CV6a
Tropisternus sp. DV5a, BV6a
Helochares sp. BV6a, CV6a
Berosus sp. EV5a

Carabidae (Family).....Ground Beetles
Numerous species, not yet identified DV5a, EI2a, AVI2a,
AVI2a, HIlla

Heteroceridae (Family).....Varigated Mud-Loving Beetles
Heterocerus sp. EV10a, CV14a

Coccinellidae (Family).....Ladybird Beetles
Adalia bipunctatia EI3L
spp. unidentified EI3a

Tenebrionidae (Family).....Darkling Beetles
Gonasida sp. DI2a, AVI9a
Eleodes sp. EI9a, GIV7a, AVI2a, MIld, MI8d
Pelecyphorus sp. JIld
Eusattus sp. MI8d, MIld
Triorophus sp. MI8a
Trogloderus sp. MIld, MI8d
Chilometropon sp. MIld
Edrotes sp. JIld

Dytiscidae (Family).....Predaceous Diving Beetles
Deronectes sp. CV6a, BV6a
Hydroporus sp. KV6a, BV6a, CV6a
Laccophilus sp. BV6a
Agabus sp. CV5L, CV6a
Hygrotus sp. EV5a

Monommidae (Family) MI8a

Scarabaeidae (Family).....Dung Beetles
Numerous species, not yet identified VI2d, FI9d, EI2d, MIld

Anthicidae (Family).....Antlike Flower Beetles
Anthicus sp. AVI2a

Lampyridae (Family).....Fireflies
Photinus sp. AVI2L

COLEOPTERA (cont'd)

Silvanidae (Family).....Flat Grain Beetles
Oryzaephilus sp. AVI10a

Buprestidae (Family).....Metallic Wood-Boring Beetles
Acmaeopera sp. EI8L
spp. unidentified MI8L

Curculionidae (Family).....Snout Beetles
Pissodes sp. GIV7L
Leptopiinae MI1a
Rhyncophorinae MI7d, MI8d, MI1d
Thylacitinae MI8d

Melyridae (Family).....Soft-winged Flower Beetles
Malachius sp. AVI7a

Limnebiidae (Family).....Minute Moss Beetles
Octhebius puncticollis EV14a, CV14a

Elateridae (Family).....Click Beetles
spp. unidentified AVI2a, MI1a, GIV7L
Aphricus sp. MI1a

Cisidae (Family).....Minute Tree-Fungus Beetles GIV7L

Dermestdae (Family)
Dermestes MI12a

DIPTERA (Order).....Flies

spp. unidentified DI3a, EI3a, AVI3a, AVI15a

Chironomidae (Family).....Midges
spp. unidentified CV10a
Chironomous plumosus DV5L, BV6L
Tendipes sp. DV5L, EV4L, BV6L
Paratendipes sp. KV6L
Diamesa sp. BV6L
Brillia sp. AI3a, CV6L
Cardiocladius sp. KV6L
Spaniotoma sp. GIV7L
Procladius sp. EV4L, BV6L
Pentaneura sp. CV6L

Muscidae (Family) BI3a

Heleomyzidae (Family) MI15a

DIPTERA (cont'd)

Culicidae (Family).....Mosquitoes
  Culiseta inornata BV6L
  Culiseta impatiens BV6L
  spp. unidentified AVI3a, EV4d

Ephydridae (Family).....Shore Flies
  Neoscatella sp. KV6L

Ceratopogonidae (Family).....Biting Midges or No-See-Ums
  Culicoides sp. KV6L
  Dasyhelea sp. CV6L, KV6L

Dolichopodidae (Family).....Long-Legged Flies CV6L, EV5L

Calliphoridae (Family).....Blow Flies
  Lucilia illustris EI12L

Trupaneidae (Family).....Fruit Flies EI1L

Cecidomyidae (Family).....Gall Gnats
  Contarinia sp. GIV7L
  Lestodiplosis sp. GIV7L, GIV7a
  Miaster sp. GIV7L

Drosphilidae (Family).....Small Fruit Flies GIV7L

Sarcophgidae (Family).....Flesh Flies
  Sarcophaga securifera EI12L

LEPIDOPTERA (Order).....Moths and Butterflies

Plutellidae (Family).....Diamond-Back Moths HI7L

Unidentified spp. (Family) DI3a, EI3a, HI3a

Nictuidae (Family)
  Laphygma exigua DI2L, AVI2L
  Chorizagrotis auxiliaris AV12L
  spp. unidentified AVI2L, MI1L, AVI11L

Pyralidae (Family).....Snout Moths
  Pyrausta ainsliei AV12L
  spp. unidentified CV14L

Arctiidae (Family).....Tigermoths GIV7L

Lyonetiidae (Family) EI8L

Gelechiidae (Family) AVI7L

COLLEMBOLA (Order).....Spring Tails

Poduridae (Family)
  Achorutes sp. AVI7a
  spp. unidentified AVI7a

Entomobryidae (Family)
  Isotomurus sp. AVI7a
  spp. unidentified GIV7a

PSOCOPTERA (Order).....Book Lice

Liposcelidae (Family) AVI7a

Psocidae (Family) AVI7a

ODONATA (Order).....Dragonflies and Damselflies

Libellulidae (Family).....Common Skippers
  Tarnetrum sp. EV4n
  Belonia sp. LV5n
  Pantala sp. EV4n

Coenagrionidae (Family).....Narrow-winged Damselflies
  Hyponeura lugens BV5n
  Ischnura perparva BV5n

THYSANURA (Order).....Bristletails

Lepismatidae (Family).....Silverfish EI1n

THYSANOPTERA (Order).....Thrips

Thripidae (Family).....Common Thrips AVI7a, GIV7a

Phloeothripidae (Family) AVI7a

ISOPTERA (Order).....Termites

Rhinotermitidae (Family) AVI11a

Termitidae (Family) JI11a

EPHEMEROPTERA (Order).....Mayflies

Baetidae (Family).....Small Mayflies
  Paraleptophlebia sp. CV6n
  Callibaetis sp. BV5n, EV4n, KV6n
  Cloeon sp. BV5n, LV5n
  Beatis sp. LV5n
  Baetodes sp. EV4n

TRICHOPTERA (Order).....Caddisflies

Limnephilidae (Family).....Northern Caddisflies
  Limnephilus sp. BV5n, CV5n

ARACHNIDA (Class)

SOLPUGIDA (Order).....Sunspider

Eremobatidae (Family) JI2n

SCORPIONIDA (Order).....Scorpions

Vejovidae (Family)
  Vejovis flavus DII1a
  Anuroctonus sp. MI2a

Buthidae (Family)
  Centruroides sculpturatus AIV2a

PHALANGIDA (Order).....Daddy Long-Legs

Phalangidae (Family)
  Lacinius sp. JI2n

ARANEIDA (Order).....Spiders

Clubionidae (Family)
  Phrurolithus sp. EI2a

Anyphaenidae (Family)
  Anyphaena sp. DI2a

Theridiidae (Family)
  Lythyphantes sp. EI1a
  spp. unidentified HI3a, MI2a

Lycosidae (Family).....Wolf Spiders
  Trochosa sp. CI10a
  Pardosa sp. DI3a, DII1a, DI1a, CI10a, HI10a, AVI2a
  Schizocosa sp. AVI2a

Araneidae (Family)
  Mongora sp. DI3a

Pholcidae (Family)
  Psilochorus sp. DI1a, JI2a, MI1a

ARANEIDA (cont'd)

Micryphantidae (Family) GIV7a

Plectreuridae (Family)
   Plectreurys sp. EI1a, MI1a, JI2a

Thomisidae (Family).....Crab Spiders
   Ebo sp. AVI13a
   Philodromus sp. AVI13a, AVI2a, FVI1a
   Misumenops sp. GIV7a, MI12a, MI2a
   Synema sp. EI1a
   Thanatus sp. MI1a

Agelenidae (Family)
   Cicurina robusta FVI1a

Gnaphosidae (Family)
   Gnaphosa sp. EI1a, FVI1a
   Sergidlus sp. AVI2a
   Haploorassus sp. FVI1a, MI1a

Dictynidae (Family)
   Dictyna sp. DI3a

Tetragnathidae (Family)
   Tetragnatha sp. AVI3a

Filistatidae (Family)
   Filistata sp. MI2a

ACARI (Subclass).....Mites

ACARIFORMES (Order)

Caeculidae (Family) AVI7a

Damaeidea (Family) AVI7a, GIV7a

Bdellidae (Family) AVI7a

Euphthiracaridae (Family) AVI7a

Eremaeidae (Family) AVI7a, GIV7a

Oribatellidae (Family) AVI7a, GIV7a

Trombidiidae (Family) AVI7a, GIV7a

ACARIFORMES (cont'd)

Neophyllobiidae (Family) AVI7a

Cymbaeremaeidae (Family) AVI7a

Cheyledidae (Family) AVI7a

Camisiidae (Family) AVI7a

PARASITIFORMES (Order)

Discourellidae (Family) AVI7a

Rhodacaridae (Family) AVI7a

Pachylaelapidae (Family) AVI7a

CRUSTACEA (Class)

COPEPODA (Subclass)

EUCOPEPODA (Order).....Copepods

Cyclopidae (Family) LV5a

OSTRACODA (Subclass)

PODOCOPA (Order).....Seed Shrimp

Cypridae (Family) DV5a, EV4a

CHILOPODA (Class).....Centipedes

ANAMORPHA (Subclass)

LITHOBIOMORPHA (Order)

Henicopidae (Family) AVI2a

Lithobiidae (Family) GIV7a

Following is a list of insects previously reported in the Kaiparowits Basin.

Those insects in the list whose presence we have confirmed in our collecting are preceded by a letter. The letter used indicates the taxonomic level to which they have been confirmed, i.e.:

(F) Confirmed to family

(G) Confirmed to genus

(S) Confirmed to species

The insects in the following list were collected as incidentals by O. King in 1958 while he worked as a member of a crew surveying the vegetation of the Kaiparowits Basin. The specimens were identified by Beng C. Ho of the University of Utah Museum.

TERRESTRIAL INSECTS

ORTHOPTERA (Order).....Grasshoppers, crickets and allies

(F) Acrididae (Family).....Short-horned grasshoppers
Crytacanthacridinae sp.

Tettigoniidae (Family).....Long-horned grasshoppers

HEMIPTERA (Order).....Bugs

Pentatomidae (Family).....Stink bugs
Chlorochroa sp.

Reduviidae (Family).....Kissing bugs

COLEOPTERA (Order).....Beetles

Cerambycidae (Family).....Long-horned beetles
Prionus californicus

(F) Chrysomelidae (Family).....Leaf beetles
Nodonota puncticollis

COLEOPTERA (cont'd)

(F) Scarabeidae (Family).....June beetles
Polyphylla crinata

(F) Carabidae (Family).....Ground beetles

Pselaphidae (Family).....Ant-loving beetles

Coccinellidae (Family).....Ladybird beetles
Hippodamia convergens

Mordellidae (Family).....Tumbling flower beetles
Mordella sp.

LEPIDOPTERA (Order).....Butterflies and Moths

Nymphalidae (Family).....Brush-footed butterflies
Argynnis eurynome

Danaidae (Family).....Milkweed butterflies
Danaus plexippus

Satyridae (Family).....Satyrs

DIPTERA (Order).....Flies

(F) Culicidae (Family).....Mosquitoes
Aedes vexans

(F) Dolichopodidae (Family).....Long-legged flies

Nemestrinidae (Family).....Nemestrinids
Hyrmophloeba sp.

Asilidae (Family).....Robber flies
Pseudorus sp.

(F) Sarcophagidae (Family).....Flesh flies
Hystricocnema plinthopyga

Pipunculidae (Family).....Big-eyed flies

Bombyliidae (Family).....Bee flies
Anthrax tigrina

HYMENOPTERA (Order).....Bees, Wasps, Ants and Allies

Pompilidae (Family).....Spider wasps
Pepsis sp.

HYMENOPTERA (cont'd)

Apidae (Family).....Bumble bees
Bombus terricola
Bombus impatiens
Bombus borealis

Sphecidae (Family).....Sphecid - wasps
Sphecius grandis
Sphecinae sp.
Nyssininae sp.
Philanthinae sp.

Vespidae (Family).....Vespid wasps
Polistes texanus
Eumeninae sp.

Megachilidae (Family).....Leaf-cutter bees
Callanthidium sp.

Mutillidae (Family).....Velvet ants
Dasymutilla klugii

Tiphiidae (Family)

(F) Halictidae (Family).....Sweat bees
Sphecodes sp.

(F) Formicidae (Family).....Ants
Pognomyrex occidentalis comanche
Myrmecocystus mexicanus hortideorum

AQUATIC INSECTS

EPHEMEROPTERA (Order).....Mayflies

Oligoneuriidae (Family)
Homoeoneuria sp.
Lachlania powelli
Heptagenia elegantula

Baetidae (Family)
(G) *Baetis* sp.
(G) *Callibaetis* sp.

Leptophlebiidae (Family)
Traverella albertana

Tricorythidae (Family)
Tricorythodes sp.

ODONATA (Order).....Dragonflies and Damselflies

Gomphidae (Family).....Dragonflies
   Progomphus borealis
   Gomphus intricatus

Aeshnidae (Family).....Dragonflies
   Anax walsinghami
   Aeshna palmata

Libellulidae (Family).....Dragonflies
   Libellula comanche
   Libellula saturata
   (G) Tarnetrum corruptum
   Paltothemis lineatipes
   (G) Pantala hymenaea

Lestidae (Family).....Damselflies
   Archilestes grandis

(F) Coenagrionidae (Family).....Damselflies
   Argia emma
   Argia vivida
   Argia sedula
   Enallagma

HEMIPTERA (Order).....Bugs

Corixidae (Family) Waterboatmen
   (S) Graptocorixa abdominalis
   (G) Corisella tarsalis

Notonectidae (Family).....Back swimmers
   (S) Notonecta kirbyi
   Notonecta lobata
   (S) Notonecta undulata
   Notonecta unifasciata

Naucoridae (Family).....Creeping water bugs
   Ambrysus mormon

Belostomatidae (Family)
   Lethocerus americanus

Gelastocoridae (Family).....Toad bugs
   Gelastocoris oculatus

Gerridae (Family).....Water striders
   (S) Gerris remigis

(F) Veliidae (Family).....Small water striders
   Microvelia americana

MEGALOPTERA (Order).....Alderflies, Dobsonflies, Fishflies

- Corydalidae (Family).....Dobsonflies
  - *Corydalus* sp.

TRICHOPTERA (Order).....Caddiceflies

- Philopotamidae (Family)
  - *Chimarra* sp.

- Psychomyiidae (Family)
  - *Polycentropus* sp.

- Hydropsychidae (Family)
  - *Hydropsyche* sp.
  - *Potamyia* sp.

- Hydroptilidae (Family)
  - *Neotrichia* sp.

- (F) Limnephilidae (Family)
  - *Hesperophylax* sp.

- Brachycentridae (Family)
  - *Brachycentrus* sp.

- Heliocopsychidae (Family)
  - *Helicopsyche* sp.

LEPIDOPTERA (Order).....Butterflies and Moths

- (F) Pyralidae (Family).....Snout moths
  - *Parargyractis kearfottalis*

COLEOPTERA (Order).....Beetles

- Haliplidae (Family).....Crawling water beetles
  - *Peltodytes simplex*

- Dytiscidae (Family).....Predaceous water beetles
  - (G) *Laccophilus decipiens*
  - *Bidessus* sp.
  - (G) *Hygrotus* sp.
  - (G) *Deronectes* sp.
  - *Oreodytes* sp.
  - (G) *Agabus* sp.
  - *Agabus* sp.
  - *Agabus lugens*
  - *Rhantus anisonychus*
  - *Rhantus binotatus*
  - *Thermonectus marmoratus*

COLEOPTERA (cont'd)

Gyrinidae (Family).....Whirligig beetles
Gyrinus plicifer

Hydrophilidae (Family).....Water scavenger beetles
(G) *Berosus punctatissimus*
Berosus maculosus
Berosus styliferus
Hydrochara lineata
Hydrophilus triangularis
(G) *Tropisternus ellipticus*
(G) *Laccobius ellipticus*
(G) *Enochrus obtusiusculus*

Dryopidae (Family).....Long-toed crawling water beetles
Helichus suturalis

Elmidae (Family).....Riffle beetles
Microcylloepus similis

DIPTERA (Order).....Flies

Tipulidae (Family).....Crane flies
Holorusia sp.

Culicidae (Family).....Mosquitoes
Anopheles franciscanus
(G) *Culiseta incidens*
Culex tarsalis
Culex sp.

Simulidae (Family).....Black flies
Simulium sp.
Simulium virgatum

Tendipedidae (Family).....Midges (Chironomidae)
Anatophnia sp.
Eukiefferiella sp.
(G) *Paratendipes* sp.
Paratendipes albimanus
Microtendipes caducus
(G) *Tendipes* sp.
Polypedilum sp.
Polypedilum sp.
Polypedilum sp.
Tanytarsus sp.
Tanytarsus sp.
Calopsectra sp.
Calopsectra exigua

DIPTERA (cont'd)

Stratiomyidae (Family).....Soldier flies
   Euparyphus sp.
   Stratiomys sp.

Tabanidae (Family).....Horse flies, deer flies and allies
   Chrysops sp.
   Tabanus sp.

Empididae (Family).....Dance flies
   Hemerodromia sp.

(F) Ephydridae (Family).....Ephydrid flies
   Brachydeutera sp.

Schiomyzidae (Family).....Marsh flies
   Dictya sp.

APPENDIX II-15

Reptiles and Amphibians of Kaiparowits Plateau

APPENDIX II-15

Wildlife

Reptiles and Amphibians of Kaiparowits Plateau*

Basis for listing: F = Field studies after Lake Powell formed

L = Literature prior to Lake Powell

		Habitat Type				
SCIENTIFIC NAME	COMMON NAME	Canyon Bottom & Streamside	Rocky Slopes	Desert	Grassland	Woodland
Lizards						
Crotaphytus collaris	collared lizard		F	F		
Crotaphytus wislizenii	long-nosed leopard lizard	L		F	F	
Sauromalus obesus	chuckwalla	L	L	F		
Holbrookia maculata	speckled earless lizard			F		
Sceloporus magister	Utah spiny lizard	L	L	F		
Sceloporus undulatus	plateau lizard		L	L		
Sceloporus graciosus	Great Basin sagebrush lizard		F	L		
Uta ornata	tree lizard		L			F
Uta stansburiana	side blotched uta		L	F	F	F
Phrynosoma douglassii	short-horned lizard		L	F		
Phrynosoma platyrhinos	desert horned lizard		L	F		
Xantusia vigilis	night lizard			L		
Cnemidopherus velax	plateau whiptail	L	L	L		
Cnemidopherus tigris	whiptail		L	F		

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*This list includes some species recorded by earlier studies which encompassed terrain outside but adjacent to the project impact area. Also, earlier studies covered habitat along Colorado River now inundated by Lake Powell.

(continued)

Reptiles and Amphibians of Kaiparowits Plateau

		Habitat Type				
SCIENTIFIC NAME	COMMON NAME	Canyon Bottom & Streamside	Rocky Slopes	Desert	Grassland	Woodland
	Snakes					
Masticophis taeniatus	desert striped whipsnake	L		L		
Thamnophis crystopsis	black-necked garter snake	L				
Thamnophis elegans	wandering garter snake	L	L			
Salvadora heralepis	Mohave patch nosed snake	F	F		F	
Pituophis cantenifer	gopher snake	L	L	F	F	
Lampropeltus getulus	king snake	L		F		
Hypsiglena torquata	Mesa Verde night snake	L				
Crotalus viridus	western rattlesnake		F	F	F	F
	Amphibians					
Ambystoma tigrinum	tiger salamander	L				
Scaphiopus hammondi	western spadefoot toad	L				
Bufo cognatus	plains toad			F		
Bufo punctatus	red spotted toad	F				
Bufo woodhousei	Rocky Mountain toad	F				
Hyla arenicolor	canyon tree frog	L				
Pseudacris triseriata	cricket frog	L				
Rana pipiens	leopard frog	L				

APPENDIX II-16

Species List of Lake Powell Fish - Past and Present

APPENDIX II-16

Wildlife

Species list of Lake Powell Fish - Past and Present

Catostomidae (Family) - Suckers
- *Catostomus latipinnis (Baird and Girard) - flannelmouth sucker
- +*Pantosteus delphinus (Cope) - Colorado River mountain sucker
- *Xyrauchen texanus (Abbott) - humpback sucker

Cyprinidae (Family) - Minnows
- Cyprinus carpio (L.) - carp
- Gilia atraria (Girard) - Utah chub
- +*Gilia cypha (Miller) - humpback chub
- +*Gilia elegans (Baird & Girard) - bonytail chub
- *Gilia robusta (Girard & Baird) - Colorado or roundtail chub
- +*Notropis lutrensis (Baird & Girard) - red shiner
- Pimephales promelas (Rafinesque) - fathead minnow
- *Ptychocheilus lucius (Girard) - Colorado squawfish
- *Rhinichthys osculus yarrowi (Jordan & Everman) - Colorado speckled dace

Ictaluridae (Family) - Catfishes
- Ictalurus melas (Rafinesque) - black bullhead catfish
- Ictalurus natalis (LeSuer) - yellow bullhead catfish
- Ictalurus punctatus (Rafinesque) - channel catfish

Cyprinodontidae (Family) - Killifishes
- + Fundulus zebriunus (Jordan & Gilbert) - southwest plains killifish

Poeciliidae (Family) -
- + Gambusia affinis (Baird & Girard) - western gambusia

Centrarchidae (Family) - Sunfishes
- Lepomis cyanellus (Rafinesque) - green sunfish
- Lepomis machrochirus (Rafinesque) - bluegill
- Micropterus salmoides (Lacepede) - largemouth bass
- # Pomoxis nigromaculatus (LeSueur) - black crappie

Percidae (Family) - Perches
- + Perca flaveseens (Mitchill) - yellow perch
- # Stizostedium vitreum (Mitchill) - walleye

Salmonidae (Family) -
- # Salmo gairdneri (Richardson) - rainbow trout
- # Salmo trutta (linnaeus) - brown troust
- # Oncorhynchus nerka (Kennerlyi) - kokanee

* Native to Colorado
+ Formerly present but may no longer occur
# New species planted in Lake Powell

APPENDIX II-17

Birds Found Along the Proposed Kaiparowits Transmission System

APPENDIX II-17

Wildlife

Birds found along the Kaiparowits transmission system

Vegetative types as shown on
Vegetative Community Map

Season of Occurrence

P -- Permanent resident
S -- Summer resident
W -- Winter resident
T -- Transient or migrant

F= Recent Field Studies- (by Southern California Edison conducted during the summer of 1974.)

L= Review of Literature

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Loons															
Common loon	*Gavia immer*	T												L	L
Red-throated loon	*Gavia stellata*	T												L	L
Grebes															
Horned grebe	*Podiceps auritus*	T												L	L
Eared grebe	*Podiceps caspicus*	T												L	L
Western grebe	*Aechmophorus occidentalis*	T												L	L
Pied-billed grebe	*Polilymbus podiceps*	W												L	L
Pelicans															
White pelican	*Pelecanus erythrorhynchos*	W												L	L
Brown pelican	*Pelecanus occidentalis*	S												L	L
Cormorants															
Double-creasted cormorant	*Phalacrocorax auritus*	W												L	L

Birds Found Along the Kaiparowits Transmission System

Season of Occurrence

P -- Permanent resident
S -- Summer resident
W -- Winter resident
T -- Transient or migrant

F= Recent Field Studies- (by Southern California Edison conducted during the summer of 1974.)

L= Review of Literature

Vegetative types as shown on Vegetative Community Map

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Herons & Bitterns															
Great blue heron	Ardea herodias	W												L	L
Green heron	Butorides virescens	W												L	L
Little blue heron	Florida caerulea	W												L	L
Common egret	Casmerodius albus	W												L	L
Snowy egret	Leucophoyx thula	W												L	L
Louisiana heron	Hydranassa tricolor	W												L	L
Black-crowned night heron	Nycticorax nycticorax	W												L	L
Least bittern	Ixotorychus exilis	W												L	L
American bittern	Botaurus lengtiginosus	W												L	L

Birds Found Along the Kaiparowits Transmission System

Season of Occurrence

P -- Permanent resident
S -- Summer resident
W -- Winter resident
T -- Transient or migrant

F= Recent Field Studies- (by Southern California Edison conducted during the summer of 1974.)

L= Review of Literature

Vegetative types as shown on Vegetative Community Map

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Ibises															
Wood ibis	*Mycteria americana*	S												L	L
White-faced ibis	*Plegadis chihi*	W												L	L
Swans, Geese & Ducks															
Whistling swan	*Olor cdumbinaus*	W												L	L
Canada goose	*Branta canadensis*	W												L	L
Black brant	*Branta nigricans*	W												L	L
White-fronted goose	*Anser albifrons*	W												L	L
Snow goose	*Chen hyperborea*	W												L	L
Ross' goose	*Chen rossii*	W												L	L
Fulvous tree duck	*Dendrocygna bicolor*	W												L	L

Birds Found Along the Kaiparowits Transmission System

Season of Occurrence

P -- Permanent resident
S -- Summer resident
W -- Winter resident
T -- Transient or migrant

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Vegetative types as shown on Vegetative Community Map

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Mallard	Anas platyrhynchos	W S									L			L	
Gadwall	Anas strepera	W									L			L	
Pintail	Anas acuta	W									L			L	
Green-winged teal	Anas carolinensis	W									L			L	
Blue-winged teal	Anas discors	W									L			L	
Cinnamon teal	Anas cyanoptera	W									L			L	
American widgeon	Mareca americana	W									L			L	
Shoveler	spatula clypeata	W									L			L	
Wood duck	Aix sponsa	W									L			L	L

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Redhead	*Aythya americana*	W												L	L
Ring-neck duck	*Aythya collaris*	W												L	L
Canvasback	*Aythya valisineria*	W												L	L
Greater scaup	*Aythya marila*	W												L	L
Lesser scaup	*Aythya affinis*	W												L	L
Common goldeneye	*Bucephala clangula*	W												L	L
Borrow's goldeneye	*Buchephala islandica*	W												L	L
Bufflehead	*Buchephala albeola*	W												L	L
White-winged scoter	*Melanitta deglandi*	W												L	L

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Ruddy duck	Oxyura jamaicensis	W												L	L
Hooded merganser	Lophodytes cucullatus	W												L	L
Common merganser	Mergus merganser	W												L	L
Red-breasted merganser	Mergus serrator	W												L	L
Vultures															
Turkey vulture	Cathartes aura	P	F		F	L	F	F	L	L	L				
Hawks, Harriers & Eagles															
Goshawk	Accipiter gentilis	P	L	L	L		L	L	L	L	L				
Sharp-shinned hawk	Accipiter striatus	P	L	L	L			L	L	L	L				
Cooper's hawk	Accipiter cooperii	P	L	L	L			F	L	L	L		L		
Red-tailed hawk	Buteo jamaicensis	P	L	L	F	L	F	L	L	F	L		L		

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Red-shouldered	Buteo lineatus	P	L							L					
Swainsons's hawk	Buteo swainsoni	P	L	L	F	L	L	L	L	L	L				
Rough-legged hawk	Buteo lagopus	P		L	L	L	L		L						
Ferruginous hawk	Buteo regalis	P		L	L	L	L	L							
Harris' hawk	Parabuteo unicinctus	P	L						L	L	L				
Golden eagle	Aguila chrysaetos	P	L	L	L	L	F	L	L	L	L				
Bald eagle	Haliaeetus leucocephalus	W			L	L	L				L				
Marsh hawk	Circus cyaneus	P		L							L			L	
Osprey Osprey	Pandion haliaetus	W									L				L

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Falcons															
Prairie falcon	Falco mexicanus	P		L	L	L	L				L		L		
Peregrine falcon	Falco peregrinus	W		L	L	L	L						L		
American kestrel	Falco sparverius	P	L	F	F	L	F	L	L	L	L				
Grouse															
Sage grouse	Centrocepcus urophasianus	P		L	L										
Quail, Partridge & Pheasants															
Scaled quail	Callipepla squamata	P				L	L								
California quail	Lephortyx californicus	P						F		F		L			
Gambel's quail	Lophortyx gambelii	P	F		F	L	F					L			
Mountain quail	Oreortyx pictus	P	L		L										
Ring-necked pheasant	Phasianus colchicus	P										L			

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White-winged pheasant	*Phasianus colchicus bianchii*	P										L			
Chukar	*Alectoris graeca*	P	L	L									L		
Turkeys															
Turkey	*Meleagris gallopavo*	P	L	L											
Cranes															
Sandhill crane	*Grus canadensis*	W										L		L	L
Rails, Gallinules & Coots															
Virginia Rail	*Rallus limicola*	W									L			L	L
Sora	*Porzana carolina*	W									L			L	L
Common gallinule	*Gallinula chloropus*	W									L			L	L
American coot	*Fulica americana*	W									L			L	L
Plovers															
Snowy plover	*Charadrius alexandrinus*	T									L			L	

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Killdeer	Charadrius vociferus	W									L			L	
Mountain plover	Eupoda montana	W									L			L	
American golden plover	Plurialis dominica	T									L			L	
Snipe, Sandpipers, etc.															
Common snipe	Capella gallinago	W									L			L	
Long-billed curlew	Numenius americanus	W									L			L	
Whimbrel	Numenius phaeopus	W									L			L	
Upland plover	Bartramia longicauda	T									L			L	
Spotted sandpiper	Actitis macularia	W									L			L	
Willet	Catoptrophorus semipalmatus	W									L			L	

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Greater yellowlegs	Totanus melanoleucus	W									L			L	
Lesser yellowlegs	Totanus flauipes	T									L			L	
Pectoral sandpiper	Erolia melanotos	T									L			L	
Baird's sandpiper	Erolia bairdii	T									L			L	
Least sandpiper	Erolia minutilla	W									L			L	
Dunlin	Erolia alpina	W									L			L	
Long-billed dowitcher	Limnodromus scolopaceus	W									L			L	
Stilt sandpiper	Micropalama	T									L			L	
Western sandpiper	Ereunetes mauri	W									L			L	

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Marbled godwit	*Limosa fedoa*	W									L			L	
Sanderling	*Crocethia alba*	W									L			L	
Avocets & Stilts															
American avocet	*Recurvirostra americana*	W												L	
Black-necked stilt	*Himantopus mexicanus*	W												L	
Phalaropes															
Wilson's phalarope	*Steganopus tricolor*	T												L	
Northern phalarope	*Lobipes lobatus*	T												L	
Gulls & Terns															
Herring gull	*Larus argentatus*	W												L	L
California gull	*Larus californicus*	W												L	L
Ring-billed gull	*Larus delawarensis*	W												L	L

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Bonaparte's gull	Larus philadelphia	W												L	L
Foster's tern	Sterna foresteri	W												L	L
Least tern	Sterna albifrons	W												L	L
Caspian tern	Hydroprogne caspia	W												L	L
Black tern	Chilidonias niger	W												L	L
Pigeons & Doves															
Band-tailed pigeon	Columba fasciata	W	L						L						
Rock dove	Columba livia	P										L			
White-winged dove	Zenaida asiatica	S										L			
Mourning dove	Zenaida macroura	S	F	F	F	L	F	L	L	F	L	L			

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Spotted dove	Streptopelia chinensis	P										L			
Ground dove	Columbigallina passerina	P										L			
Inca dove	Scardafella inca	P										L			
Cuckoos & Roadrunners															
Yellow-billed cuckoo	Coccyzus americanus	T									L				
Roadrunner	Geococcyx californianus	P	L		F	L	F			F					
Owls															
Barn owl	Tyto alba	P	L	L							L	L	L		
Screech owl	Otus asio	P	L								L	L	L		
Flammulated owl	Otus flammeolus	W	L												
Great horned owl	Bubo virginianus	P	L	L	L	L	L	L	L	L	L	L		L	

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Snowy owl	Nyctea scandiaca	W		L							L				
Pygmy owl	Glaucidium gnoma	P	L								L		L		
Burrowing owl	Speotyto cunicularia	P		L	F		F					L			
Long-eared owl	Asio otus	S	L						L	L	L				
Short-eared owl	Asio flammeus	P		L								L			
Saw-whet owl	Aegolius acadicus	W	L												
Goatsuckers															
Whip-poor-will	Caprimulgus vociferus	P							L		L				
Poor-will	Phalaenoptilus nittallii	W	L		L	L	L						L		
Common nighthawk	Chordeiles minor	S	L	F			F	L			L				

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Lesser nighthawk	Chordeiles actipennis	S		L	F	L	F								
Swifts															
Vaux's swift	Chaetura vauxi	P											L		
White-throated swift	Aeronautes saxatalis	W	F		F		F								
Hummingbirds															
Black-chinned hummingbird	Archilochus alexandri	S			L	L	L		L		L		L		
Costa's hummingbird	Calypte costae	S			L	L	L								
Anna's hummingbird	Calypte anna	P						F		F		L			
Broad-tailed hummingbird	Selasphorus platycercus	T		L							L				
Rufous hummingbird	Selasphorus rufus	T	L								L	L			
Allan's hummingbird	Selasphorus sasin	T	L	L							L	L			

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Calliope hummingbird	Stellula calliope	T	L								L	L	L		
Kingfishers															
Belted kingfishers	Megaceryle alcyon	W												L	
Woodpeckers															
Yellow-shafted flicker	Colaptes auratus	P	L	L							L	L			
Red-shafted flicker	Colaptes cater	P	L	L				F			L	L			
Gilded flicker	Colaptes chrysoides	P			L	L	L				L				
Gila woodpecker	Centurus uropygialis	P									L	L	L		
Acorn's woodpecker	Melanerpes formicivorus	P						L	L						
Lewis' woodpecker	Asyndesmus lewis	W	L								L	L			
Yellow-bellied sapsucker	Sphyrapicus varius	W	L								L	L			

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Williamson's sapsucker	Sphyrapicus thyroideus	W	L								L				
Hairy woodpecker	Dendrocopos villosus	P	L								L	L			
Downy woodpecker	Dendrocopos pubescens	P	L								L	L			
Ladder-backed woodpecker	Dendrocopos scalaris	P	L								L	L			
Nuttal's woodpecker	Dendrocopos nuttalii	P	L								L	L			
Arizona woodpecker	Dendrocopos arizonae	P							L		L	L			
Tyrant Flycatchers															
Eastern kingbird	Tyrannus tyrannus	T	L						L		L	L			
Western kingbird	Tyrannus verticalis	P	L				F		L		L	L			
Cassin's kingbird	Tyrannus vociferans	S	F					L	L		L	L			

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Scissor-tailed flycatcher	*Muscivora forficata*	S					L				L	L			
Wied's crested flycatcher	*Myiarchus tyronnulus*	S							L			L			
Ash-throated flycatcher	*Myiarchus dinerascens*	S	F				F	F	L			L			
Olivaceous flycatcher	*Myiarchus tuberculifer*	S	L						L			L			
Black phoebe	*Sayornis nigricans*	P	F		F						L	L			
Say's phoebe	*Sayornis says*	W				L	F				L	L			
Traill's flycatcher	*Empidonax trillii*	P									L	L			
Least flycatcher	*Empidonax minimus*	T									L	L			
Hammond's-Ducky flycatcher	*Empidonax hammondii*	T	L								L				

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Gray flycatcher	*Empidonax wrightii*	W	L		L						L				
Western flycatcher	*Empidonax difficilis*	T	L								L				
Western Wood pewee	*Contopus sordidulus*	T	L								L				
Olive-sided flycatcher	*Nuttallornis borealis*	S	L								L				
Vermillion flycatcher	*Pyrocephalus rubinus*	P					L				L				
Larks															
Horned lark	*Eremophila alpestris*	S		F	F	L	F	L							
Swallows															
Violet-green swallow	*Tachycineta thalassina*	S	L				F				L	L	L		
Tree swallow	*Iridoprocne bicolor*	W									L	L	L		
Bank swallow	*Riparia riparia*	T												L	

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Rough-winged swallow	Stelgdopteryx fulicollis	T												L	
Barn swallow	Hirundo rustica	P												L	
Cliff swallow	Petrocholidon pyrrhonota	P		F										L	
Purple martin	Progne subis	P										L			
Jay, Magpies and Crows															
Steller's jay	Cyanocitta stelleri	P	L						L	L					
Scrub jay	Aphelocoma coerulescens	P	L					F	L	F		L			
Black-billed magpie	Pica pica	P	L	L	L	L	L	L	L	L	L	L	L		
Common raven	Corvus corax	P	F	F	F	L	L	F	L	L	L	L	L		
Common crow	Corvus brachyrhynchos	P	L	L	L	L	L	L	L	L	L	L	L		

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Pinon jay	Gymnorhinus cyanocophala	P	F	F	L		F								
Clark's nutcracker	Nucifraga columbiana	P	L												
Chickadees & Titmice															
Mountain chickadee	Parus gambeli	P	L												
Plain titmouse	Parus inornatus	P	F						L	L	L				
Verdin	Auriparus flaviceps	P						L							
Common bushtit	Psaltriparus minimus	P	F						L	L					
Nuthatches															
White-breasted nuthatch	Sitta carolinensis	R	L						L		L				
Red-breasted nuthatch	Sitta canadensis	W	L						L		L				
Pygmy nuthatch	Sitta pygmaea	R	L						L		L				

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		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Creepers															
Brown creeper	*Certhia familiaris*	R	L												
Wrentits															
Wrentit	*Chamaea pasciata*	R								F		L			
Dippers															
Dipper (Water ousel)	*Cinclus mexicanus*	R												L	
Wrens															
House wren	*Troglodytes aedon*	W						L	L			L			
Winter wren	*Troglodytes troglodytes*	W	L					L	L			L		L	
Bewick's wren	*Thryomanes bewickii*	R	F				F	F	L	F		L			
Cactus wren	*Campylorhynchus brunneicapillum*	R			F	L	F								
Long-billed marsh wren	*Telmatodytes palustris*	W									L				
Canyon wren	*Catherpes mexicanus*	R		L	L	L	F						L		

Birds Found Along the Kaiparowits Transmission System

Vegetative types as shown on
Vegetative Community Map

Season of Occurrence

P -- Permanent resident
S -- Summer resident
W -- Winter resident
T -- Transient or migrant

F= Recent Field Studies- (by Southern California Edison conducted during the summer of 1974.)

L= Review of Literature

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Rock wren	Salpinctes obsoletus	W											L		
Mockingbirds & Thrashers															
Mockingbirds	Mimus polyglottos	T					L	F			L	L			
Catbird	Dumetella carolinensis	S						L	L		L				
Brown thrasher	Toxostoma rufum	T						L	L		L				
Bendire's thrasher	Toxostoma bendirei	T						L	L		L				
Curve-billed thrasher	Toxostoma curvirostre	P				L	F								
California thrasher	Toxostoma redivium	P						F		L	L				
LeConte's thrasher	Toxostoma locontei	P			L	L									
Crissal thrasher	Toxostoma dorsale	P			L	L					L				

Birds Found Along the Kaiparowits Transmission System

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Vegetative types as shown on Vegetative Community Map

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Sage thrasher	Oreoscoptes montanus	W			F	L	L								
Thrushes															
Robin	Turdus migratorius	S									L	L			
Varied thrush	Ixoreus nacvius	T	L								L				
Hermit thrush	Hylocichla guttata	W	L								L				
Swainson's thrush	Hylocichla ustulata	T	L								L				
Veery	Hylocichla fuscescens	S									L				
Western bluebird	Sialia mexicana	W	L		L	L					L	L			
Mountain bluebird	Sialia currucoides	W	L		L	L					L				
Townsend's solitaire	Myadestes townsendi	W	L		L	L			L	L	L				

Birds Found Along the Kaiparowits Transmission System

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Vegetative types as shown on Vegetative Community Map

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Wood thrush	Hylocichla mustelina	T	L								L				
Gnatcatchers & Kinglets															
Blue-gray gnatcatcher	Polioptila caerulea	W							L	L	L				
Black-tailed gnat-catcher	Polioptila melanura	R				L	L	F	L	F					
Golden-crowned kinglet	Regulus satrapa	W	L						L	L	L				
Ruby-crowned kinglet	Regulus calendula	W	L						L	L	L				
Pipits															
Water pipit	Anthus spinoletta	W									L	L			
Waxwings															
Bohemian waxwing	Bombycilla garrula	W	L								L	L			
Cedar waxwing	Bombycilla cedrorum	W	L								L	L			
Silky Flycatchers															
Phainopepla	Phainopepla nitens	W				L	L	F	L	F					

Birds Found Along the Kaiparowits Transmission System

Season of Occurrence

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Vegetative types as shown on Vegetative Community Map

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Shrikes															
Northern shrike	*Lanius excubiton*	W	F	F	F	L	F								
Loggerhead shrike	*Lanius lodovicianus*	W	F	F	F	L	F								
Starlings															
Starling	*Sturnus vulgaris*	R									L	L			
Vireos															
Hutton's vireo	*Vireo huttoni*	R							L	L					
Bell's vireo	*Vireo bellii*	R					L		L	L	L				
Gray vireo	*Vireo vicinior*	W	F						L	L					
Solitary vireo	*Vireo solitarius*	W							L	L					
Warbling vireo	*Vireo gilvus*	R							L	L	L				
Yellow-throated vireo	*Vireo flavifrons*	T							L	L					

Birds Found Along the Kaiparowits Transmission System

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			Vegetative types as shown on Vegetative Community Map											
		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Warblers															
Black and white warbler	Mniotilta varia	T	L						L						
Tennessee warbler	Vermivora peregrina	T							L		L				
Orange-crowned warbler	Vermivora celata	T							L		L				
Nashville warbler	Vermivora ruficapilla	T						L	L						
Virginia's warbler	Vermivora virginiae	T	L					L	L						
Lucy's warbler	Vermivora luciae	P					L				L				
Myrtle warbler	Dendroica coronata	W	L					L	L						
Audubon's warbler	Dendroica auduboni	W						L	L			L			
Black-throated gray warbler	Dendroica nigrescens	W	F					L	L						

Birds Found Along the Kaiparowits Transmission System

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Vegetative types as shown on
Vegetative Community Map

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Townsend's warbler	Dendroica townsendi	T	L					L	L						
Black-throated green warbler	Dendroica virens	T	L												
Hermit warbler	Dendroica occidentalis	T	L					L	L						
Grace's warbler	Dendroica graciae	W						L	L						
Blackpoll warbler	Dendroica striata	T	L					L	L						
Ovenbird	Seiurus aurocapillus	T						L	L						
Northern waterthrush	Seiurus noveboracensis	T												L	
MacGillivray's warbler	Oporonis tolmiei	W						L	L		L				
Yellowthroat	Geothlypis trichas	W									L				

Birds Found Along the Kaiparowits Transmission System

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Vegetative types as shown on Vegetative Community Map

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Yellow-breasted chat	Icteria virens	P									L				
Wilson's warbler	Wilsonia pusilla	P									L				
American redstart	Setophaga ruticilla	T						L	L						
Painted redstart	Setophaga picta	W	L					L	L						
Worm-eating warbler	Helmitheros vermivorus	T						L	L						
Parula warbler	Parula americana	T						L	L						
Cerulean warbler	Dendroica cerulep	T						L	L						
Hooded warbler	Wilsonia citrina	T						L	L						
Weaver Finches															
House sparrow	Passer demesticus	P	L	L	L	L	L	L	L	F	L	L	L	L	

Birds Found Along the Kaiparowits Transmission System

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Vegetative types as shown on Vegetative Community Map

Meadow Larks, Blackbirds & Orioles		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Western meadowlark	*Sturnella neglecta*	S		F	F			F				L			
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	W									L				
Red-winged blackbird	*Agelaius phoeniceus*	W										L			
Orchard Oriole	*Icterus spurius*	S						L	L			L			
Hooded oriole	*Icterus cucullatus*	S						L	L			L			
Scott's oriole	*Icterus parisorum*	S	L				F	L	L						
Bullock's Oriole	*Icterus bullockii*	S						L	L			L			
Rusty blackbird	*Euphagus carolinus*	W								L				L	
Brewer's blackbird	*Euphagus cyocephalus*	W											L	L	

Birds Found Along the Kaiparowits Transmission System

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Vegetative types as shown on Vegetative Community Map

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Boat-tailed grackle	Cassidix mexicanus	S											L	L	
Brown-headed cowbird	Molothrus ater	W											L	L	
Tanagers															
Western tanager	Piranga ludoviciana	S	L					L	L						
Hepatic tanager	Piranga flava	S	L					L	L						
Summer tanager	Piranga rubra	S									L				
Grosbeaks, Finches, Sparrows & Buntings															
Cardinal	Richmondena cardinalis	R									L	L			
Rose-breasted grosbeak	Pheucticus ludovicianus	T									L	L			
Black-headed grosbeak	Pheucticus melanocephalus	S	L					L	L		L	L			
Blue grosbeak	Guiraca caerulea	S									L			L	

Birds Found Along the Kaiparowits Transmission System

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Vegetative types as shown on Vegetative Community Map

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Indigo bunting	*Passerina cyanea*	S									L	L			
Lazuli bunting	*Passerina amoena*	W		L	L						L	L		L	
Dickcissel	*Spiza americana*	P									L	L			
Evening grosbeak	*Hesperiphona vespertina*	S	L						L	L	L	L			
Purple finch	*Carpodacus purpurpeus*	P	L							L					
Cassin's ginch	*Carpodacus cassinii*	P	L												
House finch	*Carpodacus mexicanus*	P				F	F			L	L				
Pine siskin	*Spinus pinus*	P	L					L	L						

Birds Found Along the Kaiparowits Transmission System

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Vegetative types as shown on Vegetative Community Map

		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
American goldfinch	Spinus tristis	P									L	L			
Lesser goldfinch	Spinus psaltria	P									L	L			
Lawrence's goldfinch	Spinus lawrencei	P							L	L					
Red crossbil	Loxia curvirostra	P	L												
Green-tailed towhee	Chlorura chlorura	P	L		L				L	L					
Rufous-sided towhee	Pipilo erythrophthalmus	P	L					F	L	F	L	L			
Brown towhee	Pipilo fuscus	P	L					F	L	F			L		
Abert's towhee	Pipilo alberti	P					L				L			L	
Lark bunting	Calamospiza melanocorys	W			L	L	L								

Birds Found Along the Kaiparowits Transmission System

Vegetative types as shown on
Vegetative Community Map

Season of Occurrence

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		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Savannah sparrow	Passerculus sandivichensis	P		L											
Grasshopper sparrow	Ammodramus savannarum	P		L							L	L			
Baird's sparrow	Ammodramus bairdii	T		L											
Vesper sparrow	Pooecetes gramineus	P		L	L						L	L			
Lark sparrow	Chondestes grammacus	P		L	L						L	L			
Cassin's sparrow	Aimophila cassinii	P		L											
Black-throated sparrow	Amphispiza bellineate	P			F		F								
Sage sparrow	Amphispiza belli	P		L	L	L	L	L	L	L					
Slate-colored junco	Junco hyemalis	W							L	L	L	L			

Birds Found Along the Kaiparowits Transmission System

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		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
Oregon junco	Junco oreganus	W	L						L	L	L	L			
Grey-headed junco	Junco canicops	W	L						L	L	L	L			
Tree sparrow	Spizella arborea	W									L	L		L	
Chipping sparrow	Spizella passerina	W	F						L	L	L	L			
Brewer's sparrow	Spizella breweri	W									L	L			
Black-chinned sparrow	Spizella atrogularis	S			L				L	L					
Harris' sparrow	Zonotrichia querula	W	L						L	L	L	L			
White-crowned sparrow	Zonotrichia leucophrys	W							L	L	L	L			
Golden-crowned sparrow	Zonotrichia alricapilla	W							L	L	L	L			

Birds Found Along the Kaiparowits Transmission System

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		Season of Occurrence	Pinyon-Juniper woodland	Plains & desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Cliff & Rocks	Lakes, Ponds & Streams	Colorado River
White-throated sparrow	*Zonotrichia albicollis*	W	L						L	L	L	L			
Fox sparrow	*Passerella iliaca*	W	L						L	L	L	L			
Lincoln's sparrow	*Melospiza lincolnii*	P									L	L			
Song sparrow	*Melospiza georgiana*	P									L	L			
Lapland longspur	*Calcarius lapponicus*	W		L								L			

APPENDIX II-18

Mammals Found Along the Proposed Kaiparowits Transmission System

APPENDIX II-18

Wildlife

Mammals found along the proposed Kaiparowits transmission system
(continued)

X = Review of Literature

		Area inhabited by species					Vegetative types as shown on Vegetative Community Map														
		Southern Utah	Southern Nevada	Arizona, North of Colorado River	Arizona, South of Colorado River	Southern California	Pinyon-Juniper Woodland	Plains and desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Ponderosa Pine	Caves	Buildings	Hollow trees	Rocky Areas
Pouched Mammals																					
Virginia opossum	Didelphis marsupialis					X						X									
Insect Eaters																					
Shrews																					
Masked shrew	Sorex cinereus	X					X														
Merriam shrew	Sorex merriami	X	X	X	X			X	X												
Vagrant shrew	Sorex vagrans	X		X	X										X						
Dusky shrew	Sorex obscurus	X					X								X						
Ornate shrew	Sorex ornatus					X						X		X							
Dwarf shrew	Sorex nanus			X			X	X													
Northern water shrew	Sorex palustris		X												X						
Grey shrew	Notiosorex crawfordi		X		X	X		X	X	X	X	X	X	X							
Moles																					
California mole	Scapanus latimanus					X						X		X	X						
Bats																					
Leafnose bat	Macrotus californicus		X	X	X	X					X	X	X	X		X		X	X		
Little brown myotis	Myotis lucifugus	X		X	X		X	X					X	X	X	X		X	X	X	
Yuma myotis	Myotis yumanensis	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cave Myotis	Myotis velifer					X							X					X	X		
Arizona myotis	Myotis occultus					X							X					X	X		
Long-eared myotis	Myotis evotis	X	X	X	X	X	X						X	X		X		X	X	X	
Fringed myotis	Myotis thysanodes	X	X	X	X	X							X	X		X		X	X		
California myotis	Myotis californicus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		
Small-footed myotis	Myotis subulatus	X	X	X	X	X							X	X		X		X	X	X	

Mammals found along the proposed Kaiparowits transmission system

F = Recent field studies by California. Edison

X = Review of Literature

		Area inhabited by Species				Vegetative types as shown on Vegetative Community Map																
		Southern Utah	Southern Nevada	Arizona - North of Colorado R	Arizona - South of Colorado R	Southern California	Pinyon-Juniper Woodland	Plains and desert grassland	Great basin desert shrub	Sonoran desert shrub	Mohave desert shrub	Coastal sage shrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Ponderosa pine	Caves	Buildings	Hollow trees	Rocky Areas	Mountains
Flesh-eaters																						
Bears																						
Black bear	Ursus americanus	X		X	X	X																X
Racoons																						
Racoon	Procyon lotor	X	X	X	X	X									X							
Ringtail																						
Ringtail	Bassariscus astutus	X	X	X	X	X									X			X			X	
River Otter																						
Weasel, badger, and skunks																						
Longtail weasel	Mustela frenata	X			X	X	X	X	X	X		X	X	X	X	X	X					
River otter;	Lutra canadensis			X	X										X							
Badger	Taxidea taxus	X	X	X	X	X		X	F	X	X	X			X							
Spotted skunk	Spilogale putorius	X	X	X	X	X		X				X	X	X	X	X					X	
Striped skunk	Mephitus mephitis	X	X	X	X	X		X	X	X	X	X	X	X	X	X						
Hognose skunk	Conepatus leucontus				X								X								X	
Dogs, Foxes																						
Coyote	Canis latrans	F	X	X	X	X	X	X	F	X	X	X	X	X	X	X	X					
Red fox	Vulpes fulva	X	X	X			X	X														
Kit fox	Vulpes macrotis	X	X	X	X	X	X				X											
Gray fox	Urocyon cineroargentus	X	X	X	X	X						X	X	X								

(continued)

Mammals found along the proposed Kaiparowits transmission system

X = Review of Literature

Bats continued

		Area inhabited by Species					Vegetative types as shown on Vegetative Community Map															
		Southern Utah	Southern Nevada	Arizona - North of Colorado R	Arizona - South of Colorado R	Southern California	Pinyon-Juniper Woodland	Plains and desert grassland	Great basin desert shrub	Sonoran desert shrub	Mohave desert shrub	Coastal sage shrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Ponderosa Pine	Caves	Buildings	Hollow trees	Rocky Areas	Mountains
Silver-haired bat	Lasionycteris noctivagans	X	X	X	X	X	X				X		X	X		X		X	X			
Western pipistrel	Pipistrellus hesperus	X	X	X	X	X	X				X	X	X	X	X	X		X	X		X	
Big brown bat	Eptesicus fuscus	X	X	X	X	X	X		X		X		X	X	X	X		X	X	X		
Red bat	Lasiurus borealis	X	X	X	X	X	X						X	X	X			X		X		
Hoary bat	Lasiurus cinereus	X	X	X	X	X	X		X			X	X	X	X							
Western yellow bat	Lasiurus ega					X	X				X											
Spotted bat	Euderma maculata	X	X	X	X	X					X							X	X			
Western big-eared bat	Plecotus townsendi	X	X	X	X	X												X	X			
Pallid bat	Antrozous pallidus	X	X	X	X	X			X			X	X	X				X	X	X	X	
Mexican freetail bat	Tadarida brasiliensis				X													X	X			
Pocketed freetail bat	Tadarida femorosacca				X	X			X		X	X	X	X				X			X	
Big freetail bat	Tadarida molossa	X	X	X	X	X			X		X	X	X	X				X	X		X	

(continued)

Mammals found along the proposed Kaiparowits transmission system

F = Recent field studies by California. Edison

X = Review of Literature

		Area inhabited by Species						Vegetative types as shown on Vegetative Community Map														
		Southern Utah	Southern Nevada	Arizona - North of Colorado R	Arizona - South of Colorado R	Southern California	Pinyon-Juniper woodland	Plains and desert grassland	Great basin desert desert shrub	Sonoran desert desert shrub	Mohave desert shrub	Coastal sage shrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Ponderosa pine	Caves	Buildings	Hollow trees	Rocky areas	Mountains
Gnawing Mammals																						
Squirrels																						
Whitetail prairie dog	Cynomys gunnisoni	X		X	X		X	F					X									
California ground squirrel	Citellus beecheyi					X		X				X									X	
Rock squirrel	Citellus variegatus	X	X	X	X	X															X	
Townsend ground squirrel	Citellus townsendi		X					X	X													
Spotted ground squirrel	Citellus spilosoma				X		X						X									
Roundtail ground squirrel	Citellus tereticaudus		X		X	X					X	X										
Golden-mantled squirrel	Citellus lateralis	X	X	X	X	X								X			X					
Yuma antelope squirrel	Ammospermophilus harrisi				X					X	F											
Whitetail antelope squirrel Uintah	Ammospermophilus leucurus	X	X	X	X	X	X	F	F	X	F											
Least chipmunk	Eutamias minimus	X		X			X	X	X	X	X	X										X
Cliff chipmunk	Eutamias dorsalis	X	X	X	X		F			X											X	
Merriam chipmunk	Eutamias merriami					X					X											
Uinta chipmunk	Eutamias umbrinus	X		X													X					
Panamint chipmunk	Eutamias panamintinus		X			X	X				X											
Lodgepole chipmunk	Eutamias speciosus					X											X					
Charleston mountain chipmunk	Eutamias palmeri		X				X										X				X	
Western gray squirrel	Sciurus griseus					X											X					
Tassel-eared squirrel	Sciurus aberti			X	X												X					
Red squirrel	Tamiasciurus hudsonicus	X		X	X												X					
Northern flying squirrel	Glaucomys sabrias					X	X							X			X					

(continued)

Mammals found along the proposed Kaiparowits transmission system

F = Recent field studies by California. Edison

X = Review of Literature

		Area inhabited by Species					Vegetative types as shown on Vegetative Community Map															
		Southern Utah	Southern Nevada	Arizona - North of Colorado R.	Arizona - South of Colorado R.	Southern California	Pinyon-Juniper Woodland	Plains and desert grassland	Great basin desert shrub	Sonoran desert shrub	Mohave desert shrub	Coastal sage shrub	Riparian woodland	Urban - Agricultural	Ponderosa pine	Caves	Buildings	Hollow trees	Rocky areas	Mountainous	Coastal chaparral	Interior chaparral
Pocket gophers																						
Valley pocket gopher	Thamomys bottae	X	X	X	X	X	X	X	X	X	X	X									X	X
Pocket Mice, Kangaroo Mice and Kangaroo Rats																						
Silky pocket mouse	Perognathus flavus				X		F	X	X										X			X
Apache pocket mouse	Perognathus apache				X		X	X	X													
Little pocket mouse	Perognathus longimembris	X	X	X		X	X	X	F													
Arizona pocket mouse	Perognathus amplus				X		F			X	F											
Great Basin pocket mouse	Perognathus parvus	X	X	X		X	X		X													X
Desert pocket mouse	Perognathus pencillatus		X		X	X						X										X
Rock pocket mouse	Perognathus intermedius				X						F								X			
San Diego pocket mouse	Perognathus fallax					X	X					X									X	
California pocket mouse	Perognathus californicus					X	X															
Spiny pocket mouse	Perognathus spinatus					X						X										
Longtail pocket mouse	Perognathus formosus	X	X	X		X			F		F								X			
Bailey pocket mouse	Perognathus baileyi					X													X			
Dark kangaroo mouse	Microdiposops megacephalus		X			X																
Pale kangaroo mouse	Microdiposops pallidus		X			X																
Panamint kangaroo rat	Dipodomys panamintinus		X			X	X				X											
Stephen kangaroo rat	Dipodomys stephensi					X						X										
Ord kangaroo rat	Dipodomys ordi	X	X	X	X		X	F	F													

(continued)

Mammals found along the proposed Kaiparowits transmission system

		Area inhabited by Species					Vegetative types as shown on Vegetative Community Map															
		Southern Utah	Southern Nevada	Arizona - North of Colorado R.	Arizona - South of Colorado R.	Southern California	Pinyon-Juniper woodland	Plains and desert grassland	Great basin desert shrub	Sonoran desert shrub	Mohave desert shrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Ponderosa pine	Caves	Buildings	Hollow trees	Rocky areas	Mountaineous
mice and rats, continued																						
Pacific kangaroo rat	Dipodomys agitis					X						X		X								
Desert kangaroo rat	Dipodomys deserti	X	X	X	X	X				X	X											
Merriam kangaroo rat	Dipodomys merriami	X	X	X	X	X				X	F			X								
Beaver																						
Beaver	Castor canadensis	X	X	X	X	X									X							
Mice, rats, voles, porcupine																						
Western harvest mouse	Reithrodontomys megalotis	X	X	X	X	X	X	F	X	X	X	X	X	X	X		X					
Cactus mouse	Peromyscus eremicus	X	X	X	X	X	X		F	X	F											
California mouse	Peromyscus californieus					X								X								
Canyon mouse	Peromyscus crinitus	X	X	X	X	X		F	F	X	F											
Brush mouse	Peromyscus boylei	X	X	X	X	X	X	X					X	X								
Whitefooted mouse	Peromyscus leucopus				X		X	X	X													
Pinyon mouse	Peromyscus truei	X	X	X	X	X	F	X	X												X	
Deer mouse	Peromyscus maniculatus	X	X	X	X	X	F	F	F	X	X	X	X	X	X	X	X					
Northern grasshopper mouse	Onychomys leucogaster	X	X	X	X			F	F		F		X									
Southern grasshopper mouse	Onychomys torridus	X	X	X	X	X		X	X	X	F			X								
Whitethroat woodrat	Neotoma albigula				X	X				X	F										X	
Desert woodrat	Neotoma lepida	X	X	X	X	X			F	X	F											
Stephens woodrat	Neotoma stephensi				X					X			X									
Mexican woodrat	Neotoma mexicana				X																X	

(continued)

Mammals found along the proposed Kaiparowits transmission system

F = Recent field studies by California. Edison

X = Review of Literature

		Area inhabited by Species					Vegetative types as shown on Vegetative Community Map													
		Southern Utah	Southern Nevada	Arizona - North of Colorado R.	Arizona - South of Colorado R.	Southern California	Pinyon-Juniper woodland	Plains and desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Coastal chaparral	Riparian woodland	Urban - Agricultural	Ponderosa pine	Caves	Buildings	Hollow trees
Mice, rats, voles, porcupine																				
Dusky-footed woodrat	Neotoma fuscipes					X						X		X	X					
Bushytailed woodrat	Neotoma cinerea	X	X	X	X		X		X								X			
Mountain vole	Microtus montanus		X						X						X					
California vole	Microtus californicus					X						X			X					
Longtail vole	Microtus longicaudus	X		X	X	X			X						X					
Muskrat	Ondatra zibethica	X	X	X	X	X									X					
Mexican vole	Microtus Mexicanus				X			X							X		X			
House mouse	Mus musculus	X	X	X	X	X	X						X	X						
Porcupine	Erethizon dorsatum	X	X	X	X	X	X	X	X			X	X	X	X	X				
Hare and rabbits																				
Blacktail jackrabbit	Lepus californicus	X	X	X	X	X	F	X	F	X	F	X	F	X	X	X	X			
Eastern cottontail	Sylvilagus floridanus				X					X			X		X					
Mountain cottontail	Sylvilagus muttali	X	X	X			X	X	X				X		X					
Desert cottontail	Sylvilagus auduboni	X	X	X	X	X	F	F	F	X	F	F	F							
Brush rabbit	Sylvilagus bachmani					X				X	X									

(continued)

Mammals found along the proposed Kaiparowits transmission system

F = Recent field studies by California, Edison

X = Review of Literature

		Area inhabited by Species					Vegetative types as shown on Vegetative Community Map														
		Southern Utah	Southern Nevada	Arizona - North of Colorado R.	Arizona - South of Colorado R.	Southern California	Pinyon-Juniper woodland	Plains and desert grassland	Great basin desert scrub	Sonoran desert scrub	Mohave desert scrub	Coastal sage scrub	Interior chaparral	Riparian woodland	Urban - Argicultural	Ponderosa pine	Caves	Buildings	Hollow trees	Rocky areas	Mountainous
Even-Toed Herbivores																					
Peccary	*Pecari angulatus*				X					X			X						X		
Elk	*Cervus canadensis*	X					X	X	X												
Mule deer	*Odocoileus hemionus*	X	X	X	X	X	F	X	X		F	X	X	X	F						X
Whitetail deer	*Odocoileus virginianus*				X		X	X					X	X							
Pronghorn antelope	*Antilocapra americana*	X	X	X	X	X		X													
Bighorn sheep	*Ovis canadensis*	X	X	X	X	X		X												X	X
Cats																					
Mountain lion	*Felis concolor*	X	X	X	X	X	X	X	X	X	X	X	X	X		X				X	X
Bobcat	*Lynx rufus*	X	X	X	X	X	X	X	X	X	X	X	X	X		X				X	X

(continued)

APPENDIX II - 19

Endangered, Threatened and Protected Wildlife Species Found Along the Proposed Transmission System

Wildlife

Endangered, threatened and protected wildlife species found along the proposed transmission system

Species	Location	Status[a]	Source of Status[b]
Mammals			
Spotted bat (*Euderma maculata*)	Rare along entire route	Threatened-US	2
Ringtail (*Bassariscus astutus*)	Along streams with rocks	Protected-California	4
Blackfooted ferret (*Mustela nigripes*)	Navaho Indian Reservation	Endangered-US	1
River otter (*Lutra canadensis*)	Along Colorado River	Protected-Arizona	3
Kit fox (*Vulpes macrotis*)	Throughout desert areas	Protected-Nevada	5
Gray squirrel (*Sciurus spp.*)	Ponderosa pine	Protected-Nevada	5
Red Squirrel (*Tamiasciurus spp.*)	Ponderosa pine	Protected-Nevada	5
Flying squirrel (*Glauromys spp.*)	Ponderosa pine	Protected-Nevada	5
Utah prairie dog (*Cynomys parvidens*)	Garfield County, Utah	Endangered-US	1
Stephen's kangaroo rat (*Dipodomys stephensi*)	San Jacinto, California	Rare-California	4
Porcupine (*Erethiaon dorsatum*)	Along entire line	Protected-Arizona	3
Bighorn sheep (*Ovis canadensis*)	Southern Mountains, California	Protected-California	4
Birds			
White pelican (*Pelecanus ergthrorhynchos*)	Along Colorado River	Protected-Nevada	5
White-faced ibis (*Plegadis chihi*)	Along Colorado River	Status undetermined-US	2

Endangered, threatened and protected species found along the proposed transmission system (continued)

Species	Location	Status	Source of Status
Brown Pelican (Pelecanus occidentalis)	Along Colorado River	Endangered-US	1
Turkey vulture (Cathartes aura)	Along entire route	Protected-Nevada	5
Goshawk (Accipiter gentilis)	Along streams and aspen groves	Protected-Nevada	5
Sharp-shinned hawk (Accipiter striatus)	Along streams and aspen groves	Protected-Nevada	5
Cooper's hawk (Accipiter cooperi)	Along streams and aspen groves	Protected-Nevada	5
Red-tailed hawk (Buteo jamaicensis)	Along entire route	Protected-Nevada	5
Swainson's hawk (Buteo swainsoni)	Along entire route	Protected-Nevada	5
Rough-legged hawk (Buteo lagopus)	Along entire route	Protected-Nevada	5
Ferruginous hawk (Bureo regalis)	Along entire route	Status undetermined-US	1
Harris' hawk (Parrabuteo unicinctus)	Along entire route	Protected-Nevada	5
Marsh hawk (Circus cyaneus)	Along meadow and wet areas	Protected-Nevada	5
Golden eagle (Aquila chrysaetos)	Along entire route	Protected-US	7
Northern bald eagle (Haliaeetus leucocephalus)	Along entire route	Protected-US	7
Southern bald eagle (Haliaeetus leucocephalus leucocephalus)	Southern California southern Arizona, and southern Nevada	Endangered-& Protected-US	8
Osprey (Pandion haliaetus)	Along Colorado River	Status undetermined	1
Prairie falcon (Falco mexicanus)	Along entire route	Threatened-US	2
Peregrine falcon (Falco peregrinus)	Along entire route	Endangered-US	1

Endangered, threatened and protected species found along the proposed transmission system (continued)

Species	Location	Status	Source of Status
American kestrel (*Falco sparverius*)	Along entire route	Protected Nevada	5
Sandhill cranes (*Grus canadensis*)	Along meadows Central California	Protected-California Endangered-Arizona	4 3
Mountain doves (*Eupoda montana*)	Central California	Endangered-Arizona	3
California yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	California	Rare-California	4
Roadrunner (*Geococcyx californianus*)	Along entire route	Protected-Nevada	5
Barn owl (*Tyto alba*)	Along entire route	Protected-Nevada	5
Great horned owl (*Bubo virginianus*)	Along entire route	Protected-Nevada	5
Burrowing owl (*Speoyto cunicularia*)	Along entire route	Protected-Nevada	5
Long-eared owl (*Asio otus*)	Along entire route	Protected-Nevada	5
Short-eared owl (*Asio flammeus*)	Along entire route	Protected-Nevada	5
Nighthawk (*Chordeiles spp.*)	Along entire route	Protected-Nevada	5
Belted kingfisher (*Megaceryle alcyon*)	Along water	Protected-Nevada	5
Belding's savannah sparrow (*Passerculus sandwichensis subsp.*)	Grassland-California	Endangered-California	4
Amphibians			
Vegas Valley leopard frog (*Rana pipiens fisheri*)	Vegas Valley, Nevada	Threatened-US	2

Endangered, threatened and protected species found along the proposed transmission system (continued)

Reptiles

Desert tortoise

Endangered, threatened and protected species found along the proposed transmission system (continued)

Species	Location	Status	Source of Status
Reptiles			
Desert tortoise (*Gopherus azassizi*)	Sonoran and Mohave deserts	Protected-Arizona, California, Nevada	3,4,5
Gila monster (*Heloderma suspectum*)	Sonoran and Mohave deserts	Status undetermined - US	2
Fishes			
Virgin spinedace (*Lepidomeda molliopinis*)	Virgin River, Nevada	Protected-Nevada	5
Moapa dace (*Moapa coriaces*)	Muddy River, Nevada	Endangered-US	1
Woundfin (*Plagopterus argentissimus*)	Virgin & Muddy Rivers, Nevada	Endangered-US	1
Colorado River squawfish (*Ptychocheilus lucius*)	Colorado River	Endangered-US	1
Gila topminnow (*Poeciliopsis occidentalis occidentalis*)	Verde and Agua Fria Rivers, Arizona	Endangered-US	1

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[a] Definition of Status

Endangered Species: "Those species in danger of extinction throughout all or a significant portion of their range" (Source #1).

Threatened Species: "Those species which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range" (Source #1).

Rare: A rare species is one that although not presently threatened with extinction is in such small numbers throughout its range that it may be endangered if its environment is adversely affected.

Protected: An animal which may not be taken in any way, shape, or form.

[b] Sources of Status

1. United States list of Endangered Fauna, May 1974. U.S. Department of Interior.
2. Threatened Wildlife of the United States. 1973. U.S. Department of Interior.
3. Arizona Game and Fish Laws, ARS Title 17.
4. California Department of Fish and Game Regulations, pursuant to Section 217, Fish and Game Code.
5. State of Nevada, Board of Fish and Game Commissioners, general regulation No. 1, Amendment No. 5.
6. Utah State Division of Wildlife Resources, Wildlife Resources Code of Utah.
7. Bald Eagle Act as amended.
8. 1 and 7 above.

APPENDIX II - 20

Invertebrates Found Along the Proposed Kaiparowits Transmission System

APPENDIX II-20

Wildlife

HABITAT TYPES

Invertebrates Found Along the Proposed Kaiparowits Transmission System

F=Field Studies

Common Name of Classes or Families	Scientific Name of Classes or Families	Grassland	Pinyon-juniper woodland	Chaparral	Sonoran desert scrub
Centipedes	Chilopoda			F	F
Silverfish and closely related	Thysanura	F		F	
Springtails	Collembola	F	F	F	F
Grasshoppers and closely related	Orthoptera	F	F	F	F
Crickets	Gryllidae		F	F	F
Short-horned grasshoppers	Acrididae	F	F	F	F
Mantids (praying-mantid)	Mantidae	F		F	F
Walking sticks	Phasmidae	F		F	
Long-horned grasshoppers	Tettigonidae			F	
Termites	Isoptera		F		
Webspinners	Embioptera	F			
Psocids	Psocoptera	F	F	F	F
Thrips	Thysanoptera	F	F	F	F
Bugs	Hemiptera	F	F	F	F
Leaf and plant bugs	Miridae	F	F	F	F
Lace bugs	Tingidae	F	F	F	F
Assassin bugs	Reduviidae	F	F	F	F
Milkweed bugs and others	Lyaeidae	F	F	F	F
Damsel bugs	Nabidae	F		F	
Stilt bugs	Neididae	F	F	F	F
Leaf-footed bugs	Coreidae	F			
Flower and minute pirate bugs	Anthocoridae	F			

(continued)

APPENDIX II-20

Invertebrates Found Along the Proposed Kaiparowits Transmission System

F=Field Studies

Common Name of Classes or Families	Scientific Name of Classes or Families	HABITAT TYPES Grassland	Pinyon-juniper woodland	Chaparral	Sonoran desert scrub
Negro bugs	Corimelaenidae	F			
Stink bugs	Pentatomidae	F		F	F
Ambush bugs	Phymatidae	F			
Shield bugs	Suitelleridae	F		F	
Red bugs and stainers	Pyrrhocoridae			F	
Hoppers and closely related	Homoptera	F	F	F	F
Leaf hoppers	Cicadellidae	F	F	F	F
Aphids	Aphididae	F	F	F	F
Jumping plant lice	Psyllidae	F	F	F	F
Scale insects	Coccoidea	F	F	F	F
Froghoppers and spittlebugs	Crcopidae	F	F	F	F
Fulgorid planthoppers	Fulgoroidea	F		F	F
Phylloxerans	Phylloxeridae	F		F	
Treehoppers	Membracidae	F		F	
Whiteflies	Aleyrodidae	F		F	F
Cicadas	Cicadidae			F	
Antlions and closely related	Neuroptera	F	F	F	F
Raphidiid snakeflies	Rhophididae		F		
Dusty-wings	Conoipterygidae	F		F	F
Brown lacewings	Hemorolidae	F		F	
Antlions	Myrmeleontidae	F		F	F
Green lacewings	Chrysopidae	F		F	F
Beetles	Coleoptera	F	F	F	F
Soft-winged flower beetles	Melyridae	F	F	F	F

(continued)

APPENDIX II-20

Invertebrates Found Along the Proposed Kaiparowits Transmission System

F=Field Studies

		HABITAT TYPES			
Common Name of Classes or Families	Scientific Name of Classes or Families	Grassland	Pinyon-juniper woodland	Chaparral	Sonoran desert scrub
Rove beetles	Staphylinidae	F	F	F	F
Leaf beetles and others	Chrysomelidae	F	F	F	F
Snout beetles	Curculionidae	F	F	F	F
Silken fungus beetles	Crystophagidae	F	F	F	F
Pedilid beetles	Anthicidae	F	F		
Powder-post beetles	Lyctidae	F	F		
Skin beetles and others	Dermestidae		F		
Blister beetles	Meloidae		F		
Click beetles	Clasteridae	F		F	F
Metallic wood-boring beetles	Buprestidae	F			
Drugstore and death-watch beetles	Anobiidae	F			
Ladybugs	Coccinellidae	F			F
Minute brown scavenger beetles	Lathridiidae	F	F	F	F
Darkling beetles	Tenebrionidae		F		
Ground beetles	Carabidae	F	F	F	
Seed beetles and others	Bruchidae	F	F	F	F
Antlike flower beetles	Anthicidae	F		F	
June beetles and others	Scarabaeidae	F		F	
Predaceous diving beetles	Dytiscidae	F			
Shining flower beetles	Phalacridae	F			
Checkered beetles and others	Cloridae	F		F	F
Hister beetles	Historidae	F		F	
False darkling beetles	Melandryidae	F		F	
Round fungus beetles	Leiodidae	F	F	F	

(continued)

APPENDIX II-20

Invertebrates Found Along the Proposed Kaiparowits Transmission System

F=Field Studies

Common Name of Classes or Families	Scientific Name of Classes or Families	HABITAT TYPES Grassland	Pinyon-juniper woodland	Chaparral	Sonoran desert scrub
Tumbling flower beetles	Mordellidae	F			F
Long-horned wood-boring beetles	Ceramdycidae	F		F	
Short-winged mold beetles	Pselaphidae			F	
Sap beetles	Nitidulidae			F	F
Caddisflies	Trichoptera	F	F	F	
Butterflies and moths	Lepidoptera	F	F	F	F
True flies	Diptera	F	F	F	F
Robber flies	Gsilidae	F	F	F	
Rootgnats	Sciaridae	F	F	F	F
Gallignats	Cecidomyudae	F	F	F	F
Long-legged flies	Dolichopodidae		F		
Tachinid flies	Tachinidae	F	F	F	F
Small fruit flies	Drosophilidae	F	F	F	F
Anthomyiid flies	Anthomyiidae		F	F	F
Humpbacked flies	Phoridae	F	F	F	
Shore flies	Ephydridae		F		
Black scavenger flies	Sepsidae	F		F	
Frit and stem flies	Chloropidae	F		F	
House and stable fly and others	Muscidae	F		F	
Midges	Chironomidae	F			
Trixoscelid flies	Trixoscelidae	F			
Minute black scavenger flies	Scatopsidae	F		F	
Biting midges	Ceratopagonidae	F		F	F
Mosquitos	Cylicidae	F			
Bee flies	Bombylidae	F		F	F
Big-headed flies	Pipuniulidae	F		F	

(continued)

APPENDIX II-20

Invertebrates Found Along the Proposed Kaiparowits Transmission System

F=Field Studies

Common Name of Classes or Families	Scientific Name of Classes or Families	HABITAT TYPES Grassland	Pinyon-juniper woodland	Chaparral	Sonoran desert scrub
Flower flies	Syrpidae	F		F	
Lauxaniid flies	Lauxaniidae	F		F	
Dance flies	Empididae	F		F	F
Fruit flies	Tephritidae	F		F	F
Flesh flies	Sarcophagidae	F		F	
Stiletto flies	Therevidae	F		F	
Fungus gnats	Myscetophilidae			F	
Blow flies	Calliphoridae			F	
Leaf-miner flies	Agomyzidae			F	
Picture-winged flies	Otitidae			F	
Helcomyzid flies	Helcomyzidae			F	
Ants, bees, and closely related	Hymenoptera	F	F	F	F
Braconids	Braconidae	F	F	F	F
Chalcids	Chalcidordea	F	F	F	F
Gall wasps and others	Cynysoidea	F	F	F	F
Velvet ants	Mutillidae		F	F	
Ants	Formicidae	F	F	F	F
Ichneumons	Ichneumonidae	F	F	F	
Parasitic Hymenoptera	Proctotrupoidea	F	F	F	F
Parasitic Hymenoptera	Bethyloidea	F		F	F
Sphecoid wasps	Sphecoidea	F		F	
Vespoid wasps	Vespoidea	F			
Chalcids	Chalkidoidea	F		F	
Parasitic wasps and ants	Scoloidea	F			
Bees	Apoidea	F		F	

(continued)

APPENDIX II-20

Invertebrates Found Along the Proposed Kaiparowits Transmission System

F=Field Studies

		HABITAT TYPES			
Common Name of Classes or Families	Scientific Name of Classes or Families	Grassland	Pinyon-juniper woodland	Chaparral	Sonoran desert scrub
Scorpions	Scorpionida			F	
Mites and ticks	Arcarina	F	F	F	F
Spiders	Araneida	F	F	F	F
Solpugids	Solpugida		F	F	

APPENDIX II - 21

Reptiles and Amphibians Found Along the Proposed Kaiparowits Transmission System

APPENDIX II - 21

Wildlife

Reptiles and Amphibians Found Along the Proposed Kaiparowits Transmission System

Basis for Listing: F = Recent Field Studies

L = Review of Literature

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Amphibians											
Salamanders											
Tiger salamander	Ambystoma tigrinum	L						L		L	
California newt	Taricha toroso	L									L
Ensatina	Ensatina eschecholtzi	L				L					L
Pacific slender salamander	Batrachoseps pacificus		L				L				L
California slender salamander	Batrachoseps attenuatus		L				L				L
Toads											
Western spadefoot toad	Scaphiopus hammondi	L								L	L
Great Basin spadefoot toad	Scaphiopus intermountanus					L		L	L	L	

Reptiles and amphibians found along the proposed Kaiparowits transmission system (continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Toads continued											
Western toad	Bufo boreas	L			L	L					L
Woodhouse's toad	Bufo woodhousei	L		L	L			L	L	L	
Southwestern toad	Bufo microscaphus	L						L	L	L	L
Red-spotted toad	Bufo punctatus	L			L			L	L	L	L
Great Plains toad	Bufo cognatus	L		L				L	L	L	L
Frogs											
Chorus frog	Pseudacris triseriata	L								L	
Canyon treefrog	Hyla arenicolor	L						L		L	
Pacific treefrog	Hyla regilla	L							L	L	L
Red-legged frog	Rana aurora	L									L
Leopard frog	Rana pipiens	L						L	L	L	L
Vegas Valley leopard frog	Rana pipiens fisheri	L							L		

Reptiles and amphibians found along the proposed Kaiparowits transmission system
(continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Frogs continued											
Bullfrog	*Rana catesbeiana*							L	L	L	L
Reptiles											
Desert tortoise	*Gopherus agassizi*			F				L	L	L	F
Lizards											
Banded gecko	*Coleonyx variegatus*	L	L	F		L	L	L	L	L	F
Desert iguana	*Dipsosaurus dorsalis*		L	F				L	L	F	L
Chuckwalla	*Sauromalus obesus*	L	L	L				L	L	L	L
Lesser earless lizard	*Holbrookia maculata*			L	F			L		F	
Zebra-tailed lizard	*Callisaurus draconoides*		L	F				L	F	F	F
Coachella valley fringe-toed lizard	*Uma inornata*			L							L
Mojave fringe-toed lizard	*Uma scoparia*			L							L
Collard lizard	*Crotaphytus collaris*		L	F				F	L	F	L
Leopard lizard	*Crotaphytus wislizeni*	L		F	L			L	L	F	F

Reptiles and amphibians found along the proposed Kaiparowits transmission system
(continued)

Common Name	Scientific Name	Habitat Type: Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	States Inhabited by Species Along Proposed Route: Southern Utah	Southern Nevada	Arizona	Southern California
Lizards continued											
Desert spiny lizard	Sceloporus magister	L		F		F	L	L	L	F	L
Granite spiny lizard	Sceloporus orcutti		L	L			L				L
Western fence lizard	Sceloporus occidentalis	L	L				F	L	L		F
Eastern fence lizard	Sceloporus undulatus	L	L					L		L	
Sagebrush lizard	Sceloporus graciosus	L	L	L	L	L	L	L	L	L	
Side-blotched uta	Uta stansburiana		L	F	L	F	L	F	L	F	F
Long-tailed brush lizard	Urosaurus grociosus			L					L	L	L
Coast horned lizard	Phrynosoma coronatum	L				L	F				F
Desert horned lizard	Phrynosoma platyrhinos			F				L	F	F	F
Short-horned lizard	Phrynosoma douglassii		L	L				L		L	
Flat-tailed horned lizard	Phrynosoma m'calli		L	L							L

Reptiles and amphibians found along the proposed Kaiparowits transmission system (continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Lizards continued											
Granite night lizard	*Xantusia henshawi*	L	L								L
Desert night lizard	*Xantusia vigilis*	L				L		L	L	L	L
Western skink	*Eumeces skiltonianus*	L	L		L	L	L	L	L		L
Gilbert's skink	*Eumeces gilberti*	L	L		L	L	L		L		L
Orange-throated whiptail	*Cnemidophorus hyperythrus*		L	L							L
Plateau whiptail	*Cnemidophorus velax*	L	L	L				L	L		
Western whiptail	*Cnemidophorus tigris*	L	L	F		L	L	F	L	F	F
Southern alligator lizard	*Gerrhonotus multicarinatus*				L		L				L
Gila monster	*Heloderma suspectum*		L	L				L	L	L	L
Snakes											
Western blind snake	*Leptotyphlops humilis*	L	L					L	L	L	L
Rosy boa	*Lichanura trivirgata*	L	L	L			L			L	L

Reptiles and amphibians found along the proposed Kaiparowits transmission system (continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Snakes continued											
Ringneck	Diadophis punctatus	L			L	L	L	L	L	L	L
Spotted leaf-nosed snake	Phyllorhynchus decurtatus			F					L	L	F
Racer	Coluber constrictor	L			L			L	L	L	L
Coachwhip	Masticophis flagellum	L			L	L		L	L	L	L
Striped racer	Masticophis lateralis	L		F			L				F
Striped whipsnake	Masticophis taeniatus	L		L		L	L	L	L	L	L
Western patch-nosed snake	Salvadora hexalepis	L	L	L			L	L	L	L	L
Glossy snake	Arizona elegans	L	L	L	L	L	L	L	L	L	L
Gopher snake	Pituophis melanoleucus	L	L	L	L	L	L	L	L	L	L
Common kingsnake	Lampropeltis getulas	L		L	L		L	L	L	L	L
California mountain kingsnake	Lampropeltis zonata					L	L				L

Reptiles and amphibians found along the proposed Kaiparowits transmission system
(continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Snakes continued											
Long-nosed snake	Rhinochailus lecontei			L	L			L	L	L	L
Western garter	Thamnophis elegans	L	L	L		L		L		L	
Western aquatic garter snake	Thamnophis couchi	L									L
Black-necked garter snake	Thamnophis crystops			L		L	L			L	
Western ground snake	Sonora semianulata		L	L				L	L	L	L
Western shovel-nosed snake	Chionactis occipitalis		L	L					L	L	L
Western black-headed snake	Tantilla planiceps		L	L		L	L	L	L	L	L
California lyre snake	Trimorphodon vanderburghi		L	L							L
Sonora lyre snake	Trimorphodon lambda		L	L	L	L		L	L	L	L
Night snake	Hypsiglena torquata		L	L	L	L	L	L	L	L	L
Western diamond back rattlesnake	Crotalus atrox	L	L	L	L	L				L	L

Reptiles and amphibians found along the proposed Kaiparowits transmission system
(continued)

Common Name	Scientific Name	Habitat Type						States Inhabited by Species Along Proposed Route			
		Streamside and Canyon Bottom	Rocky Slopes	Desertscrub	Grassland	Woodland-Pinyon Juniper	Chaparral	Southern Utah	Southern Nevada	Arizona	Southern California
Snakes continued											
Red diamond rattlesnake	*Crotalus ruber*	L	L	L	L						L
Speckled rattlesnake	*Crotalus mitchelli*	L	L	L	L			L	L	L	L
Sidewinder	*Crotalus cerastes*	L	L	L	L			L	L	L	L
Western rattlesnake	*Crotalus viridus*	L	L	L	L			L	L	L	L
Mohave rattlesnake	*Crotalus scutulatus*	L	L	L	L			L	L	L	L

APPENDIX II- 22

Fishes Found Along the Proposed Kaiparowits Transmission System

APPENDIX II- 22

Wildlife

Fishes Found Along The Proposed Kaiparowits Transmission System

		Species Location Verde River	Agua Fria River	Virgin River	Muddy River	Colorado River	Lake Powell and Lake Mead
Herring and Shad							
Treadfin shad	*Dorosoma petensense atchafalayae*					L	L
Salmon and Trout							
Coho salmon	*Oncorhynchus kisutch*					L	L
Kokanee salmon	*Oncorhynchus nerka*					L	L
Rainbow trout	*Salmo gairdneri*	L				L	L
Brown trout	*Salmo trutta*					L	L
Carps and Minnows							
Long fin dace	*Agosia chrysogaster*	L	L				
Goldfish	*Carassius auratus*						L
Carp	*Cyprinus carpio*					L	L
Roundtail chub	*Gila robusta*			L	L	L	L
Swiftwater - Roundtail chub	*Gila robusta elegans*			L		L	L
Virginia spinedace	*Lepidomeda mollispinis*			L			
Moapa dace	*Moapa coriacea*				L		

Fishes found along the proposed Kaiparowits transmission system
(continued)

		Species Location					
		Verde River	Agua Fria River	Virgin River	Muddy River	Colorado River	Lake Powell and Lake Mead
Golden shiner	*Notemigonus crysoleucas*					L	L
Red shiner	*Notropis lutrensis*					L	L
Fathead minnow	*Pimephales promelas*	L				L	L
Woundfin	*Plagopterus argentissimus*			L			
Speckled dace	*Rhinichthys osculus*					L	L
Suckers							
Sonora sucker	*Catostomus insignis*		L				
Mountain sucker	*Catostomus platyrhynchus*		L	L	L	L	L
Humpback sucker	*Xyrauchen texanus*			L	L	L	L
Catfishes							
Black bullhead	*Ictalurus melas*					L	L
Yellow bullhead	*Ictalurus natalis*	L				L	L
Channel catfish	*Ictalurus punctatus*	L				L	L
Smallmouth bass	*Micropterus dolomieui*	L					
Livebearers							
Mosquito fish	*Gambusia affinis*	L		L	L	L	L
Shortfin molly	*Poecilia mexicana*				L	L	L

Fishes found along the proposed Kaiparowits transmission system (continued)

		Species Location					
		Verde River	Agua Fria River	Virgin River	Muddy River	Colorado River	Lake Powell and Lake Mead
Gila topminnow	*Poeciliopsis occidentalis occidentalis*	L	L				
Sunfishes							
Green sunfish	*Lepomis cyanellus*					L	L
Bluegill	*Lepomis macrochirus*					L	L
Largemouth bass	*Micropterus salmoides*					L	L
Black crappie	*Pomoxis nigromaculatus*					L	L
Perches							
Walleye	*Platyrhynchus vitreum vitreum*					L	L

APPENDIX II - 23

Archaeological Site Descriptions

APPENDIX II- 23

Paleontological, Archaeological, and Historical

Kaiparowits Plateau impact area

Archaeological site descriptions

Lithic Scatter Sites: Thirteen sites exhibit lithic materials which include debitage, chipped and ground stone implements, and projectile points. Six sites display debitage associated with projectile points only. Absence of ground stone on these sites suggests that hunting was predominant. Seventeeen sites consisted only of debitage and unfacially flaked stone tools. Most materials are waste flakes, though some show signs of casual utilization. These sites, it would seem, were largely centers for the manufacture of stone tools which were subsequently carried elsewhere for use.

Ceramic Scatter Sites: One site, a sherd scatter, has been recorded outside the proposed plant site and one half mile radius boundaries in an area of anticipated immediate impact (so designated by virtue of the anticipated further development of the Fourmile Bench aircraft landing strip).

Lithic Ceramic Scatter Sites: Two sites, recorded on the proposed plant site, exhibited associations of pottery with a scatter of lithic material and contained no surface indications of hearth.

Lithic Campsites: Three such sites were recorded on the proposed plant site. Two more sites were recorded outside the proposed plant site boundary. This type of site exhibits surface indications of hearths in association with a scatter of lithic material.

The presence of hearths on these sites would tend to support the idea of their use as temporary habitations, especially where architectural features were noted.

Rockshelter/Habitation Sites: Cultural deposits were not found in any rockshelters on the proposed plant site. One site, 100 yards in diameter, showing heavy concentrations of exposed cultural deposits and inferrentially buried continuous deposits of lithic debitage, sherds, and stone tools, and possible architectural units, perhaps including domestic houses was recorded. This site represents the most significant single archaeological resource located in the Fourmile Bench locality. Based on present knowledge, this site is of major significance considering all other remains located and studied to date.

Masonry Sites: One such site was identified on the proposed plant site. It consists of a one-unit structure, probably utilized for storage. The fact that the site is inaccessible without special equipment precluded any investigation of its contents.

No historic sites dating prior to 1950 were found on the plant site or adjacent area.

Coal mine site and adjacent area

Lithic Scatter Sites: Eighteen sites were recorded within the proposed coal mine area. Two additional sites were in adjacent sections. Of these, nineteen were characterized by the presence of only flaked stone tools. One site displayed an association of ground stone with flaked stone artifacts.

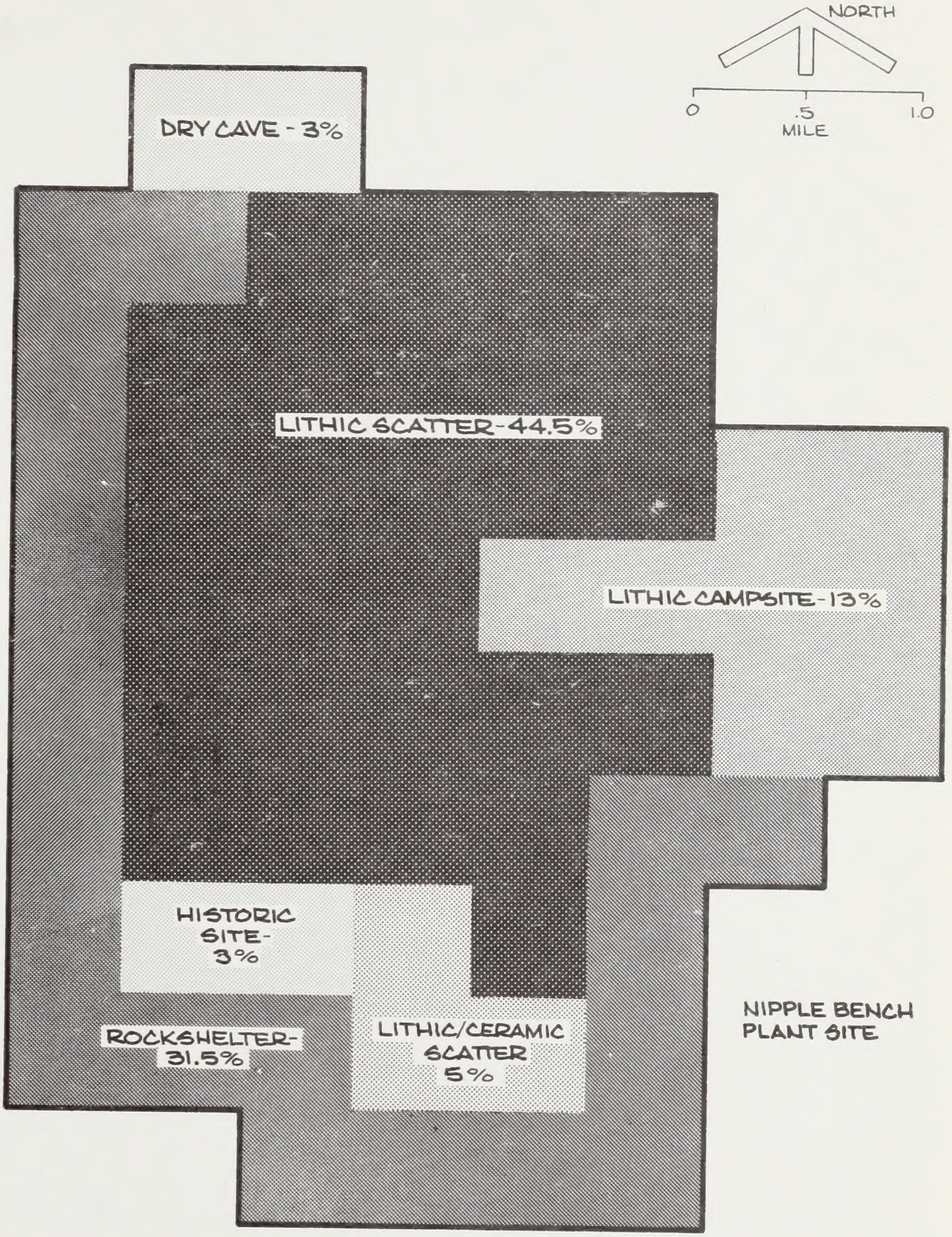
Lithic/Ceramic Scatter Sites: One site of this class was in an area adjacent to the proposed coal mine site. It was characterized by an association of debitage with a limited number of sherds, apparently from a single vessel.

Lithic Campsites: Five campsites of this nature are in the proposed coal mine area. Two have hearths associated with ground and flaked stone tools. The remaining sites have hearths and flaked stone tools only.

Rockshelter Sites: Two rockshelter complexes with associated cultural material were present in the proposed coal mine site. An additional shelter with cultural material was found in an adjacent section.

Historic Sites: An historic site consisting of a tent foundation and associated juniper and brush corrals is located within the proposed coal mine site.

Artifacts associated with this site suggest it to be a product of modern sheep herding activity.



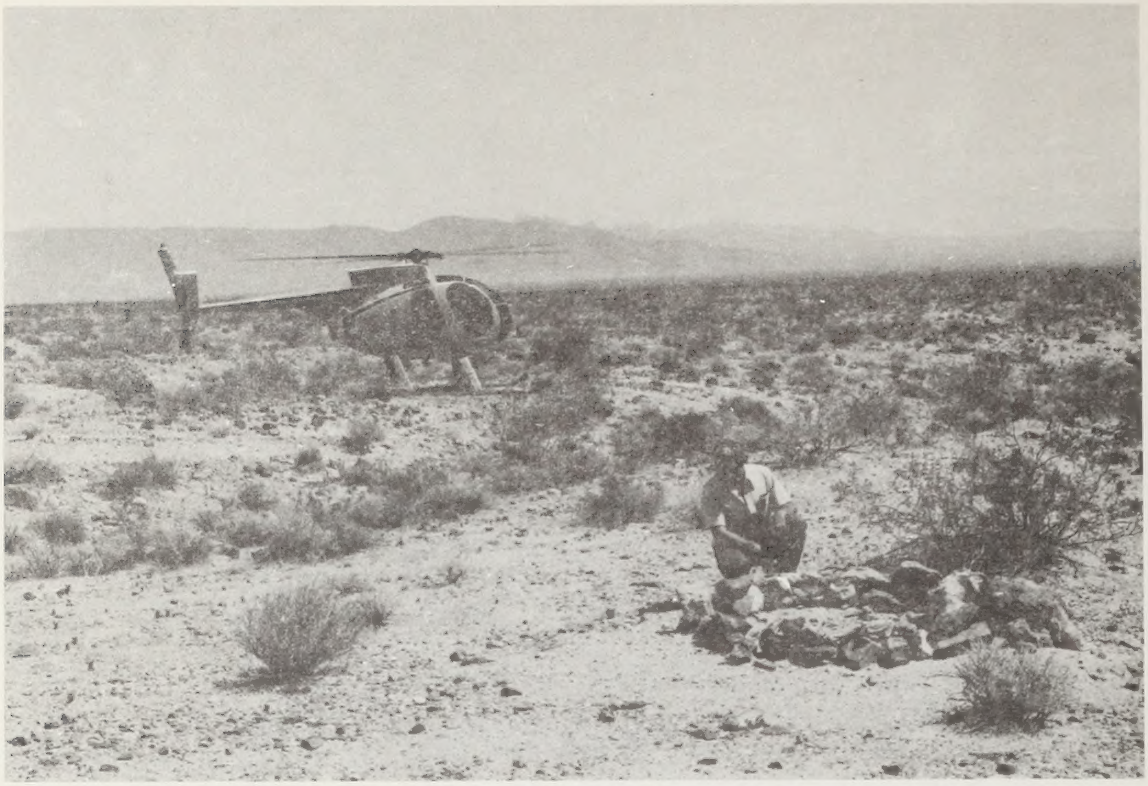
PERCENTAGE DISTRIBUTION
OF ARCHAEOLOGICAL SITE TYPES
ON PROPOSED NIPPLE BENCH PLANT SITE

ILLUSTRATON I

APPENDIX II-24

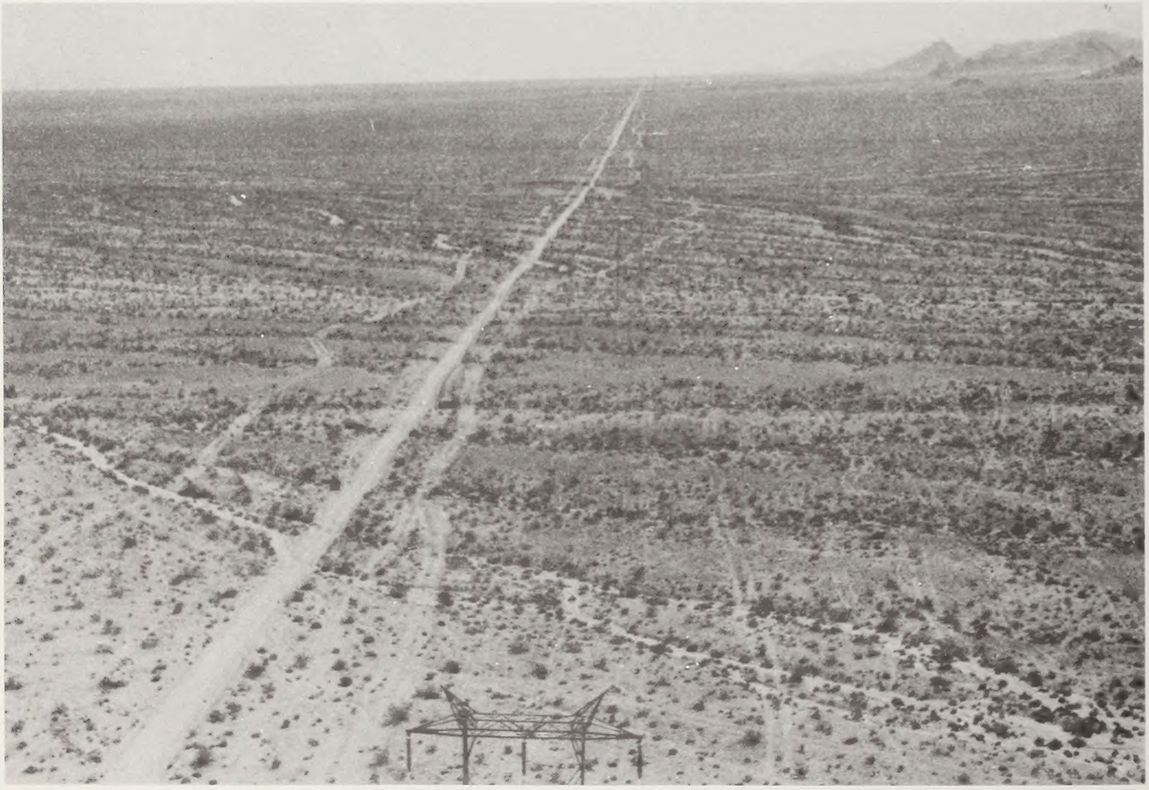
Archaeological Site Photographs

Transmission System, Mohave to Serrano Route



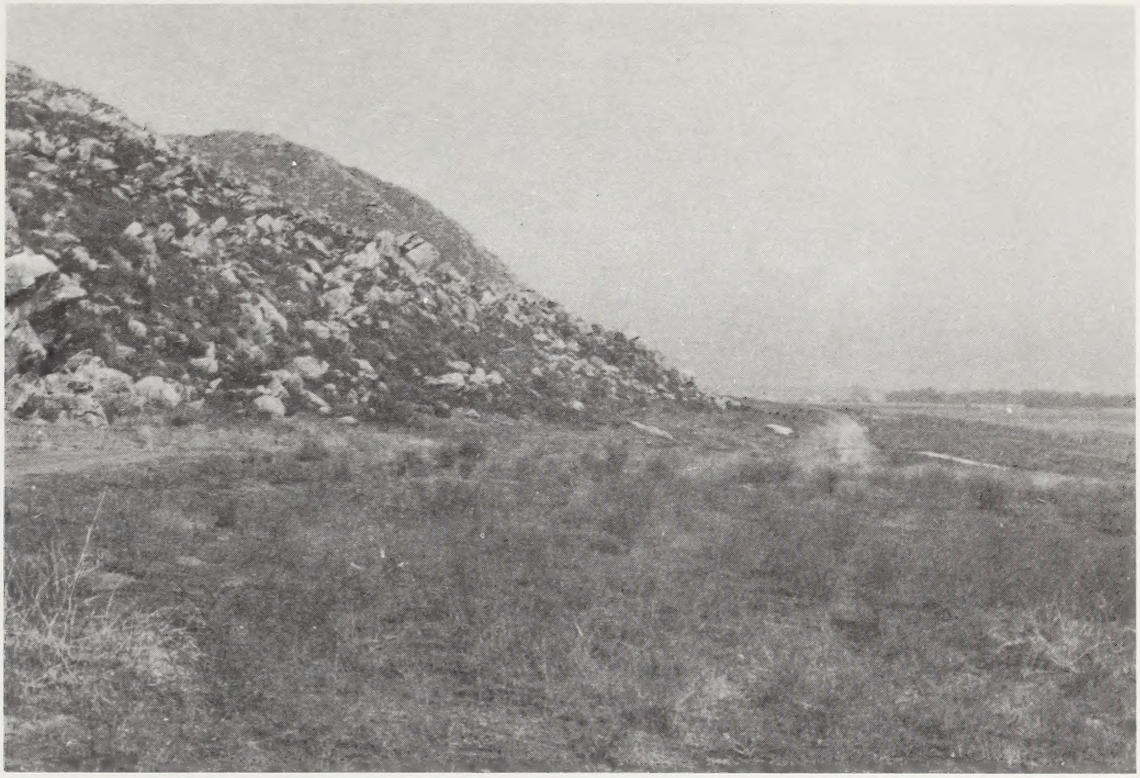
Structure ring, archaeological site K-1,
Little Paiute Mountains, California

ILLUSTRATION 1



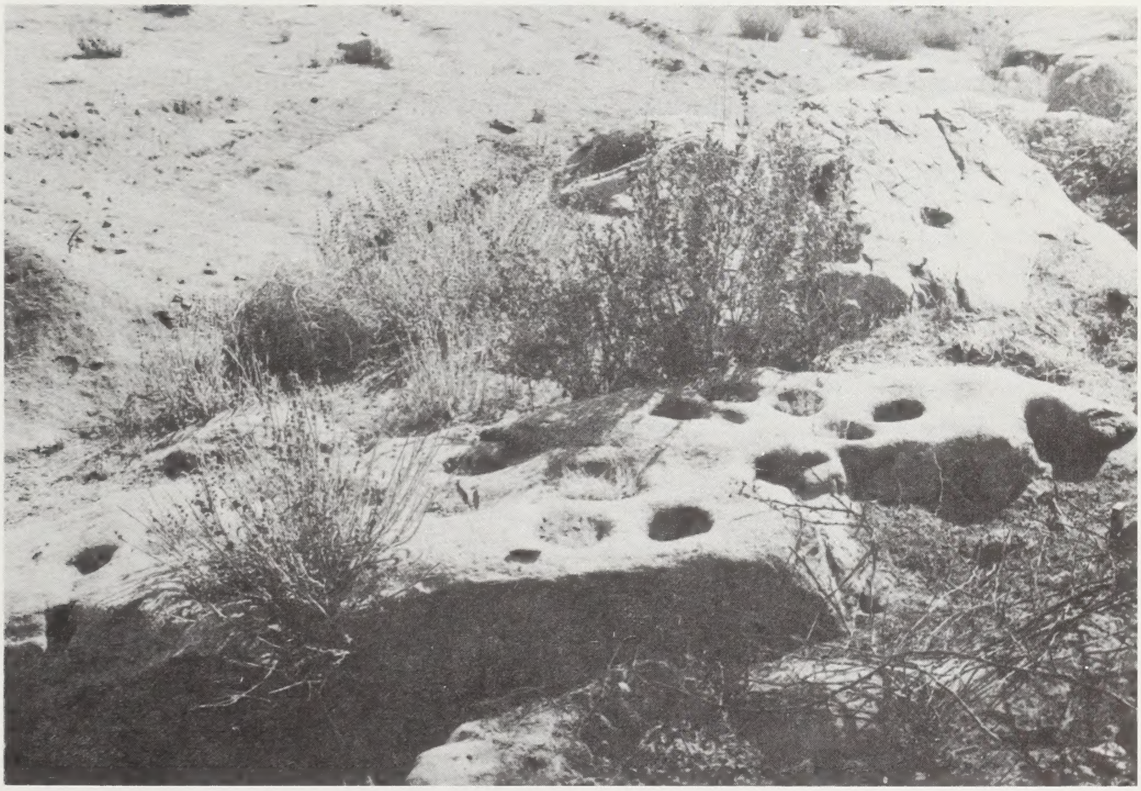
Aerial view of archaeological site K-1
Little Paiute Mountains-Ward Valley,
California, showing old fan remnants

ILLUSTRATION 2



General view northwest of archaeological site
CA-Riv-399, San Jacinto Valley, California

ILLUSTRATION 3



Bedrock mortar feature at CA-Riv-399
San Jacinto Valley, California

ILLUSTRATION 4

APPENDIX II-25

Population Forecasting, Tax Revenue, Housing, and Public Opinion Poll

APPENDIX II-25

Socio-Economic

Population Forecasting, Tax Revenues, Housing, and Public Opinion Poll

The number of workers in the plant and mines can be predicted with considerable accuracy, because the participants have experience with similar projects. The participant's estimate of basic employment is contained in Chapter I. Basic employment generates "secondary employment." "Secondary" simply means that jobs are generated by needs that arise to serve basic employees. The product of basic employment is exported from the area (in this case, power is exported to Arizona and California), whereas the product of secondary employment is consumed by residents within the immediate area.

An "employment multiplier" is the average number of secondary and basic jobs expected to result from creation of the average basic job. Assuming that a new town will be established at the Glen Canyon City area, the expected employment multipliers for three areas are shown in Figure 1. The same figure contains "dependent multipliers" for the same areas. A dependent multiplier is the average number of people dependent upon each job. The figure is smaller than a figure for family size would be, because an average of more than one person is expected to be employed from each family.

Population projections for Page, Arizona based on the influence of the Navajo Plant (without Kaiparowits) are shown in Figure 2.

Criteria for projecting tax revenues

The assessed value of property in Utah for computing property taxes is an average of 20 percent of the real value. This 20 percent figure is then taxed at the rate of .05436. The real value of the plant when completed is expected to be $1,800,000,000. Mine property is currently assessed in Utah by estimating the value of the ore in the ground. However, a task force has made recommendations

FIGURE 1

Population Forecasting Multipliers

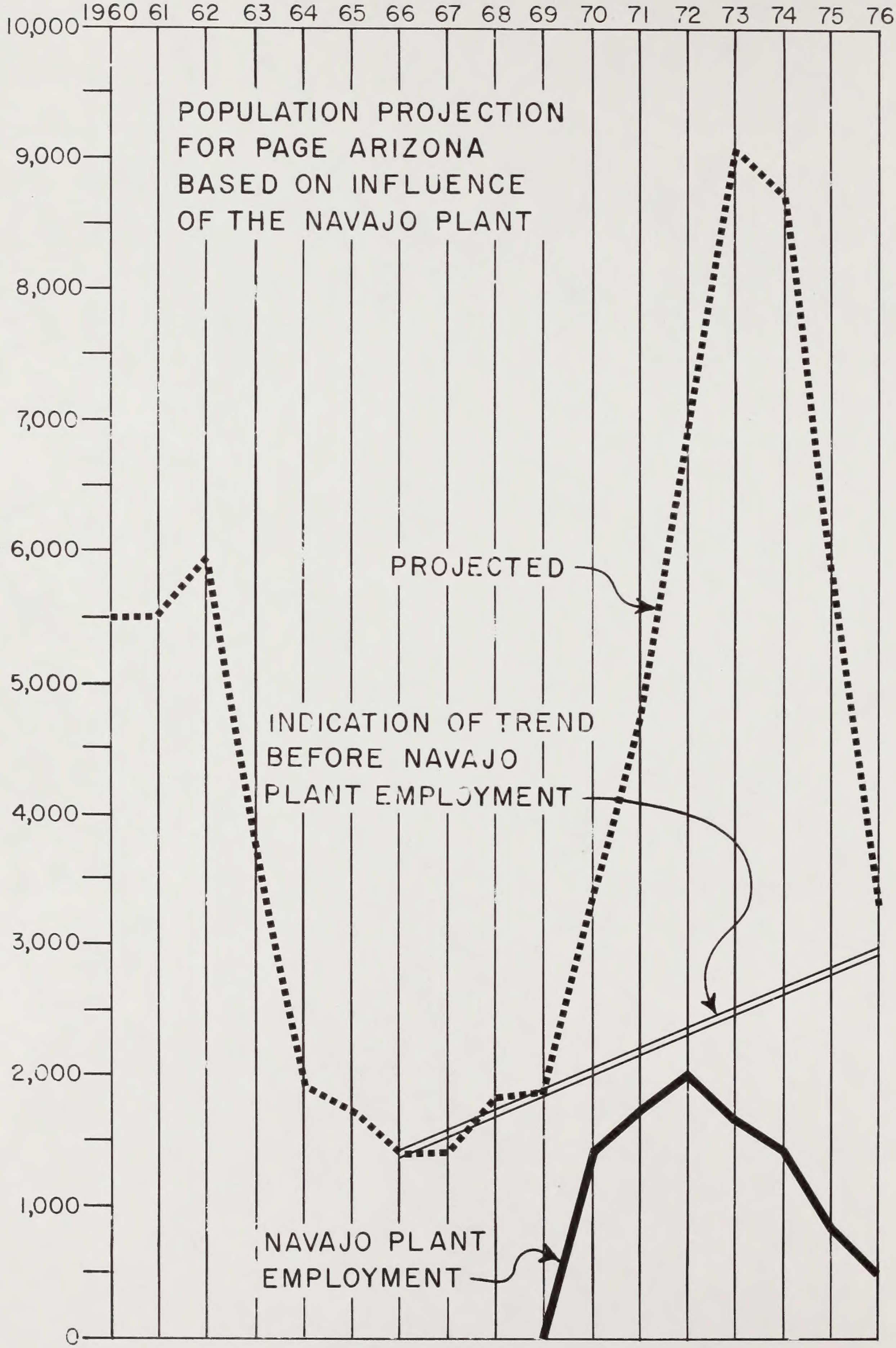
For the Kaiparowits Employment

	New Town	Garfield Co.	Page Arizona	
Year 1*	1.15	1.50	2.5	Employment Multiplier
2	1.30	1.56	2.5	
3	1.45	1.62	2.5	
4	1.60	1.68	2.5	
5	1.75	1.74	2.5	
6	1.90	1.80	2.5	
7	2.0	1.86	2.5	
8	2.0	1.92	2.5	
9	2.0	1.98	2.5	
10	2.0	2.04	2.5	

	New Town	Garfield Co.	Page Arizona	
Year 1	1.70	1.75	2.0	Dependent Multiplier
2	1.81	1.80	2.0	
3	1.92	1.85	2.0	
4	2.0	1.90	2.0	
5	2.0	1.95	2.0	
6	2.0	2.00	2.0	
7	2.0	2.05	2.0	
8	2.0	2.10	2.0	
9	2.0	2.15	2.0	
10	2.0	2.20	2.0	

*12 months after construction begins

FIGURE 2


1960
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
POPULATION PROJECTION
FOR PAGE ARIZONA
BASED ON INFLUENCE
OF THE NAVAJO PLANT
PROJECTED
INDICATION OF TREND
BEFORE NAVAJO
PLANT EMPLOYMENT
NAVAJO PLANT
EMPLOYMENT

for changing this procedure and a method of computing value based on net income is expected to be adopted soon. This later criterion was used in this study subsequent to the first few years of construction. The expected production of coal and limestone is estimated, then the net income calculation that will probably be applied is used ($4,000,000 for each million ton), this is then divided by the capitalization rate of .15 to reach an estimate of real value.

Sales tax in Utah (except for Salt Lake and Weber Counties) is 4.0 percent with a local option of .5 percent. Federal coal lease royalties are divided so that the state gets 37.5 percent and the federal government gets 62.5 percent. The proposal includes a transfer of land to the state for the plant site which they intend to sale to the companies for $300 an acre. "Use and sales tax" refers to a tax assessed on all items that are imported and used in the state even though they are not resold in the state, and items that are purchased in the state for construction. Franchise tax is assessed on all corporations in the state at the rate of six percent of net income. For companies which do business in several states a method of apportioning income is used. Companies are charged according to the portion of employees, investment, and sales in the several states.

For the purpose of computing income taxes, it is assumed that workers in the limestone quarry would pay an average $317 in state taxes a year. Plant construction workers would pay #394; mine construction workers $403; plant operation workers $298; mine operation workers $461; and workers in generated employment (secondary) $216. These are about 10 percent of the amounts that would be paid in federal income taxes.

All calculations are based on assumptions according to the best information available. However, errors are expected in the estimates and it is hoped that some estimates that are too high will be balanced by some estimates that are too low.

The social psychology of housing

Dr. ElDean V. Kohrs, Clinical Director, Central Wyoming Counseling Center, Casper, Wyoming, delivered a paper to a meeting of the Rocky Mountain American Association of the Advancement of Science Meeting, held in 1974, entitled "Social Consequences of Boom Growth in Wyoming." The following is a reproduction of portions of Dr. Kohrs' paper, substantially edited for space requirements.

A housewife, after fighting mud, wind, inadequate water and disposal systems, a crowded mobile home and muddy children all day, snaps at her husband as he returns from a 16-hour shift. He responds by heading back downtown and spending the night at a bar drinking and trading stories with men from similar circumstances. This typical occurence came to be called the "Gillette Syndrome."

Divorce, tensions on children, emotional damage and alcholism were the result of growth in Gillette. Children went to school in double shifts; motels turned over linens in triple shifts. Jails became crowded; and police departments experienced frequent changes in personnel in the tradition of frontier justice. Out of frustration with the quality of living, it appeared that mayors shuttled in and out of office regardless of party like bobbins in a loom. Depression was rampant with suicide attempts at a rate of one per 250 people. Suicide attempts were rarely fatal but they became the tool to regulate the lack of human concern. It was the ultimate method to express that something was wrong and needed changing.

When neglect went beyond tolerable limits, divorce was the natural consequence. Fatigued men working long shifts and driving long distances to work came home to equally fatigued wives coping with a mudspattered world.

Trailer courts offered only a mud-patty for children's play as they raced between trailer houses and trailer court traffic. Even schools were in trailers similar to those in whichs the children lived. Nothing seemed permanent. Difficulty in coping with transient living, angry school personnel teaching under less than adequate conditions, and parental conflicts led to poor school adjustments and achiements, then truancy, then delinquency and finally sometimes a residential environment.

Like 100 years ago in Wyoming, many came looking for employment. Wide

FIGURE 3

Gillette and Campbell County Statistics

Year	City Population	County Population	Public School Enrollment
1950	2,190	4,839	694
1960	3,580	5,861	968
1968	8,000		2,456
1969-70			2,975
1970-71	7,194	12,957	3,261
1971-72	7,200		2,968
1972-73	8,000		3,146
1973-74	9,000		3,060

1970 Statistics

County	Population	School	Births	Marriages	Divorces	Ratio
Campbell	12,957	3,696	317	130	72	1.8
Carbon	13,354	3,514	237	148	54	2.7
Goshen	10,885	3,178	172	129	39	3.3

Criminal Statistics (1970)

County	Population	Arrests	Public Drunkenness	Driving Under the Influence	Criminal Budget
Campbell	12,957	1,025	134	90	$1,118,597
Carbon	13,354	614	56	20	551,507
Goshen	10,885	337	47	20	419,500

	School Drop-Outs 1969-70	Drop-Out Rate 1969-70
Campbell	70	5.0
Carbon	52	3.4
Goshen	31	2.3
Wyoming		3.4

open spaces and unlimited employment attracted workers from Florida to California. People worked hard and drank hard. There was little time for release through recreation.

Jails often became a protection of wives from beating by drunken spouses rather than detention for real crime. Psychiatric and alcoholic withdrawal problems were maintained in the jail because of overworked medical personnel and inadequate medical facilities. The hospital was a first-aid station to maintain life until the injured could be transported to a hospital in Casper, Billings or Denver.

The pattern of depression, delinquency and divorce was so well documented that the consequences were predictable. Citizens forsook the pursuit of higher needs in order to cope with the need for adequate water, sanitation, and social survival. An attitude soon developed, "Let it happen; we'll meet the crisis again." Booms are not new in Wyoming, but the social consequences are becoming increasingly clear.

The present study is based on Campbell County. Campbell County is the size of the state of Connecticut and contains one town - Gillette. From 1960 to 1970, the county grew 121 percent. The peak of the most recent boom occurred in 1970. See Figure 3.

Campbell County can be compared to two other Wyoming counties with roughly the same 1970 census population figures. Carbon County grew at a rate of zero percent and Goshen County at a rate of minus 6.7 percent from 1960 to 1970. Campbell County had a high energy boom. Carbon County had significant changes due to the coal expansion in Manna and uranium at Shirley Basin. Goshen County has continued to be a stable ranch and farm community.

As Figure 3 shows, high employment and the wealth of boom conditions does not mean fewer social problems. In fact the reverse seems to be the case. The comparative figures for divorce rates and criminal statistics are particularly revealing.

The dropout rate of 5.0 to 6.3 percent in Campbell County far exceeds Carbon, Goshen, and the State of Wyoming as a whole. The move from a stable school environment to one plagued with rapid growth and administrators unfamiliar with such conditions resulted in frequent school personnel--student confrontations. Because of high employment opportunities, many students opted for work rather than continued education unrelated to employment trends.

This issue of boom town is not politics, economics or engineering, but rather human survival at a level above existence, getting along, or even, as good as we have it now.

Since the first oil was found at Salt Creek, power production in Wyoming has wreaked a toll of human suffering, developed opportunities that flared in the boom blaze and died, or flared and continued wildfire growth without care or planning, leaving wakes as devoid of quality life support as a prairie grass burn area.

Details of public opinion poll

Random samples without replacement were taken in each of six communities, however, the proportion of people interviewed differed for each town.

A sampling error of 10 percentage points at the 95 percent confidence level means that for an estimate such as 47 percent there is a 95 percent chance that the true population percentage will fall between 37 and 57 percent. (47% - 10% = 37%) (47% + 10% = 57%).

Three types of hypotheses tests were used. For subpopulation comparisons of responses to questions used for the Page, Arizona sample, chi square tests for contingency tables were employed. A discussion of these tests can be found in Introduction to Mathematical Statistics by Hogg and Craig.

Since the sample design of the southern Utah communities was disproportionate, alternative procedures were used. For comparisons of two mean or percentage estimate, difference-of-means tests were employed. Differences of estimates were assumed to be normally distributed. A discussion of difference-of-means tests were employed. Differences of estimates were assumed to be normally distributed. A discussion of difference-of-means tests can be found in Survey Sampling by Kish.

Break-downs referred to in the text, but not explained in detail are listed on the following pages.

Southern Utah Sample

	Total	Boulder	Cannonville	Escalante	Henrieville	Kanab	Tropic
Total	350	36	40	79	46	87	62
Sex:							
Male	169	18	20	36	23	40	32
Female	181	18	20	43	23	47	30
Age:							
18-29	70	13	5	10	12	13	17
30-39	53	2	5	12	6	18	10
40-55	69	5	11	16	12	16	9
Over 55	158	16	19	41	16	40	26
Income:							
Under $8,000	194	24	28	52	24	31	35
$8,000 and over	152	12	12	25	22	54	27
Occupation:							
Professional and Business	86	11	7	13	3	33	19
Manual	156	22	16	32	32	27	27
Retired	106	3	17	34	9	27	16

Page Sample

Total	374
Residence:	
Trailer House	261
Apartment	42
Private Home	71
Sex:	
Male	184
Female	190
Age:	
18-29	111
30-39	99
40-55	111
Over 55	52
Income:	
$15,000 or less	129
Over $15,000	240
Occupation:	
Professional and Business	113
Manual	249

SOUTHERN UTAH

DO YOU FAVOR OR OPPOSE AN INCREASE IN POPULATION IN THIS COMMUNITY?

	Favor	Oppose	Don't Know
Totals	76%	20%	4%
Sex:			
Male	78	16	7
Female	76	24	1
Age:			
18-29	75	23	2
30-39	83	17	0
40-55	77	18	5
Over 55	74	20	5
Income:			
Under $8,000	76	18	6
Over $8,000	79	21	1
Occupation:			
Professional and Business	76	22	2
Manual	76	21	3
Retired	78	17	5
Area:			
Cannonville	85	15	0
Tropic	92	3	5
Henrieville	85	15	0
Boulder	61	36	3
Escalante	85	10	5
Kanab	69	28	3

DO YOU FAVOR A SLIGHT OR SUBSTANTIAL INCREASE IN POPULATION?

	Slight	Substantial
Total	38%	35%
Sex:		
Male	40	38
Female	36	32
Age:		
18-29	35	36
30-39	42	37
40-55	30	42
Over 55	40	31
Income:		
Under $8,000	37	32
$8,000 and over	38	40
Occupation:		
Professional and Business	34	37
Manual	37	37
Retired	42	31
Area:		
Boulder	42	19
Cannonville	43	35
Escalante	44	37
Henrieville	41	41
Kanab	33	31
Tropic	39	52

SOUTHERN UTAH

DO YOU FAVOR OR OPPOSE AN INCREASE IN POPULATION IN THIS COMMUNITY IF IT CAUSES LOCAL TAXES TO RISE SLIGHTLY?

	Favor	Oppose	Don't Know
Totals	54%	36%	7%
Sex:			
Male	63	30	7
Female	48	46	6
Age:			
18-29	56	38	6
30-39	66	34	0
40-55	53	35	12
Over 55	50	42	7
Income:			
Under $8,000	51	40	9
Over $8,000	60	37	3
Occupation:			
Professional and Business	52	46	3
Manual	60	32	8
Retired	51	41	8
Area:			
Cannonville	78	20	2
Tropic	69	26	5
Henrieville	70	28	2
Boulder	44	53	3
Escalante	63	28	9
Kanab	45	48	7

DO YOU FAVOR OR OPPOSE AN INCREASE IN POPULATION IN THIS COMMUNITY IF IT CAUSES LOCAL TAXES TO RISE SUBSTANTIALLY?

	Favor	Oppose	Don't Know
Totals	27%	66%	8%
Sex:			
Male	27	64	9
Female	26	68	6
Age:			
18-29	26	67	6
30-39	22	77	1
40-55	31	59	10
Over 55	27	64	9
Income:			
Under $8,000	27	61	12
Over $8,000	27	70	2
Occupation:			
Professional and Business	27	70	2
Manual	23	68	8
Retired	30	59	11
Area:			
Cannonville	45	50	5
Tropic	39	55	6
Henrieville	30	61	9
Boulder	17	81	3
Escalante	32	58	10
Kanab	21	72	7

SOUTHERN UTAH

DO YOU ANTICIPATE CHANGING YOUR EMPLOYMENT IF THIS COMMUNITY GROWS SUBSTANTIALLY?

	Yes	No	Don't Know
Totals	26%	73%	2%
Sex:			
Male	26	72	2
Female	26	73	2
Age:			
18-29	49	50	1
30-39	36	61	3
40-55	26	70	3
Over 55	13	86	1
Income:			
Under $8,000	23	76	1
Over $8,000	29	68	2
Occupation:			
Professional and Business	23	73	4
Manual	45	54	1
Retired	5	95	0
Area:			
Cannonville	45	55	0
Tropic	36	63	2
Henrieville	56	39	4
Boulder	8	92	0
Escalante	29	72	0
Kanab	20	78	2

WHICH DO YOU BELIEVE IS MOST IMPORTANT IN THIS AREA:

	Economic Development	Environmental Conservation	Both	Don't Know
Totals	61%	13%	21%	5%
Sex:				
Male	70	8	19	3
Female	53	17	22	8
Age:				
18-29	52	28	19	1
30-39	49	15	30	6
40-55	65	10	20	4
Over 55	67	8	18	8
Income:				
Under $8,000	64	11	18	8
Over $8,000	57	16	24	3
Occupation:				
Professional and Business	43	15	37	5
Manual	69	14	14	3
Retired	67	11	13	9
Area:				
Cannonville	65	5	22	8
Tropic	76	2	14	8
Henrieville	70	11	13	6
Boulder	56	11	17	17
Escalante	77	6	15	1
Kanab	49	20	25	6

SOUTHERN UTAH

DO YOU APPROVE OR DISAPPROVE OF OUTSIDE INTERESTS INVESTING MONEY IN THIS COMMUNITY?

	Favor	Oppose	Don't Know
Totals	83%	13%	4%
Sex:			
Male	87	12	1
Female	79	14	8
Age:			
18-29	81	16	4
30-39	81	15	3
40-55	86	11	3
Over 55	82	11	7
Income:			
Under $8,000	82	12	6
Over $8,000	83	13	4
Occupation:			
Professional and Business	82	15	3
Manual	81	15	4
Retired	86	7	7
Area:			
Cannonville	70	20	10
Tropic	86	8	6
Henrieville	80	11	9
Boulder	56	39	6
Escalante	90	8	2
Kanab	82	14	5

DO YOU FAVOR OR OPPOSE THE RECRUITMENT OF MINORITY GROUPS (SUCH AS INDIANS) TO WORK IN LOCAL POWER PLANTS?

	Favor	Oppose	Don't Know
Totals	83%	13%	4%
Sex:			
Male	83	12	5
Female	84	13	3
Age:			
18-29	86	12	2
30-39	84	14	3
40-55	80	12	7
Over 55	84	12	4
Income:			
Under $8,000	84	12	3
Over $8,000	83	12	5
Occupation:			
Professional and Business	79	18	3
Manual	86	10	4
Retired	84	11	5
Area:			
Cannonville	82	12	5
Tropic	73	24	3
Henrieville	91	4	4
Boulder	67	31	3
Escalante	78	11	10
Kanab	88	10	1

SOUTHERN UTAH

IN YOUR OPINION, HOW CAN GOVERNMENT AGENCIES BETTER PROTECT THE ENVIRONMENT?

	Doing Enough	Doing Too Much	Control, Protect, Enforce	Don't Listen to Ecologists	Moderate Policies	Other	Don't Know
Total	23%	17%	15%	3%	3%	5%	34%
Area:							
Boulder	14	36	6	6	6	6	28
Cannonville	12	18	8	2	5	5	50
Escalante	32	23	11	4	5	5	20
Henrieville	24	7	17	7	2	9	35
Kanab	21	14	17	2	2	3	40
Tropic	26	19	15	2	2	10	27

SOUTHERN UTAH

IN YOUR OPINION, HOW CAN GOVERNMENT AGENCIES BETTER ENCOURAGE ECONOMIC GROWTH IN YOUR AREA?

	Doing Too Much	Provide jobs, Industry, Money	Build Power Plants	Develop Resources and Improve Area	Don't Listen to Ecologists	Other	Don't Know
Total	16%	16%	16%	15%	5%	2%	30%
Area:							
Boulder	36	8	8	22	0	3	22
Cannonville	8	25	12	15	0	0	40
Escalante	10	19	16	11	11	4	28
Henrieville	13	30	9	11	2	9	26
Kanab	18	14	18	11	3	1	33
Tropic	15	11	10	37	3	0	23

PAGE, ARIZONA

RESIDENCE:

	Trailer House	Apartment	Private Home
Totals	70%	11%	19%
Sex:			
Male (N=184)	68	14	18
Female (N-190)	72	9	20
Age:			
18-29 (N=111)	69	17	14
30-39 (N=99)	75	7	18
40-55 (N=111)	71	9	20
Over 55 (N-52)	58	12	31
Income:			
$15,000 and under (N=129)	59	19	22
Over $15,000 (N-240)	76	7	18
Occupation:			
Professional and Business	51	12	36
Manual (N-249)	80	11	9

WHILE LIVING IN PAGE WOULD YOU PREFER TO LIVE IN:

	Trailer House	Apartment	Private Home	Don't Know
Total	35%	3%	60%	1%
Sex:				
Male (N=184)	32	4	63	1
Female (N=190)	39	2	57	2
Age:				
18-29 (N=111)	28	4	66	2
30-39 (N=99)	34	2	62	2
40-55 (N=111)	43	0	55	2
Over 55 (N=52)	35	8	58	0
Income:				
Under $15,000 (N=129)	22	5	69	3
Over $15,000 (N=240)	42	2	55	1
Occupation:				
Professional and Business (N=113)	23	2	74	2
Manual (N=249)	43	3	53	2

PAGE, ARIZONA

WOULD YOU SAY YOUR DWELLING IS TOO LARGE, TOO SMALL, OR ABOUT RIGHT?

	Too Large	Too Small	About Right	Don't Know
Total	1%	31%	68%	1%
Sex:				
Male (N=184)	0	35	65	0
Female (N=190)	1	26	72	1
Age:				
18-29 (N=111)	0	38	60	2
30-39 (N=99)	0	41	59	0
40-55 (N=111)	2	17	81	0
Over 55 (N=52)	0	25	75	0
Income:				
Under $15,000 (N=129)	2	36	62	1
Over $15,000 (N-240)	0	28	71	0
Occupation:				
Professional and Business (N=113)	1	25	74	0
Manual (N=249)	0	34	65	1

ARE YOUR YARD FACILITIES TOO LARGE, TOO SMALL, OR ABOUT RIGHT?

	Too Large	Too Small	About Right	Don't Know
Total	0%	36%	64%	0%
Sex:				
Male (N=184)	0	43	57	0
Female (N=190)	0	30	70	0
Age:				
18-29 (N=111)	0	47	53	0
30-39 (N=99)	0	49	52	0
40-55 (N=111)	0	24	76	0
Over 55 (N=52)	0	17	83	0
Income:				
$15,000 and under (N=129)	0	40	61	0
Over $15,000 (N=240)	0	35	65	0
Occupation:				
Professional and Business (N=113)	0	28	72	0
Manual (N=249)	0	41	59	0

HOW LONG HAVE YOU LIVED IN PAGE?

	Less than 2	2 to 10	More than 10
Total	53%	36%	10%
Sex:			
Male (N=184)	56	34	10
Female (N=189)	51	39	11
Age:			
18-29 (N=111)	69	23	7
30-39 (N=99)	50	44	5
40-55 (N=110)	50	36	14
Over 55 (N=52)	33	46	21
Income:			
$15,000 and under (N=129)	50	32	19
Over $15,000 (N=239)	56	38	6
Occupation:			
Professional and Business (N=113)	49	33	19
Manual (N=248)	57	38	5

ARE YOU PLANNING TO LEAVE PAGE IN THE NEAR FUTURE?

	Yes	No	Don't Know
Total	42%	49%	9%
Sex:			
Male (N=184)	40	51	9
Female (N=190)	43	47	10
Age:			
18-29 (N=111)	49	43	8
30-39 (N=99)	37	54	8
40-55 (N=111)	42	46	12
Over 55 (N=52)	35	56	10
Income:			
$15,000 and under (N=129)	36	58	5
Over $15,000 (N=240)	45	44	11
Occupation:			
Professional and Business (N=113)	31	63	6
Manual (N=249)	47	42	11

PAGE, ARIZONA

DO YOU FAVOR OR OPPOSE AN INCREASE IN POPULATION IN THIS COMMUNITY?

	Favor	Oppose	Don't Know
Total	55%	21%	24%
Sex:			
Male (N=183)	58	20	22
Female (N=190)	52	23	25
Age:			
18-29 (N=110)	60	24	16
30-39 (N=99)	52	27	20
40-55 (N=111)	54	14	32
Over 55 (N=52)	52	21	27
Income:			
$15,000 and under (N=129)	54	27	19
Over $15,000 (N=239)	56	18	27
Occupation:			
Professional and Business (N=113)	54	26	20
Manual (N=248)	56	18	27

DO YOU FAVOR A SLIGHT OR SUBSTANTIAL INCREASE?

	Slight	Substantial
Total	29%	24%
Sex:		
Male (N=183)	30	26
Female (N=190)	27	22
Age:		
18-29 (N=110)	32	28
30-39 (N=99)	29	22
40-55 (N=111)	25	25
Over 55 (N=52)	27	13
Income:		
$15,000 and under (N=129)	26	27
Over $15,000 (N=239)	30	22
Occupation:		
Professional and Business (N=113)	26	26
Manual (N=248)	30	23

PAGE, ARIZONA

DO YOU FAVOR OR OPPOSE AN INCREASE IN POPULATION IN THIS COMMUNITY IF IT CAUSES LOCAL TAXES TO RISE SLIGHTLY?

	Favor	Oppose	Don't Know
Total	36%	36%	28%
Sex:			
Male (N=184)	39	35	26
Female (N=190)	34	36	30
Age:			
18-29 (N=111)	35	46	19
30-39 (N=99)	39	37	23
40-55 (N=111)	40	22	39
Over 55 (N=52)	27	39	35
Income:			
$15,000 and under (N=129)	30	50	21
Over $15,000	40	28	32
Occupation:			
Professional and Business (N=113)	40	41	20
Manual (N=249)	36	31	32

DO YOU FAVOR OR OPPOSE AN INCREASE IN POPULATION IN THIS COMMUNITY IF IT CAUSES LOCAL TAXES TO RISE SUBSTANTIALLY?

	Favor	Oppose	Don't Know
Total	15%	55%	30%
Sex:			
Male (N=184)	17	54	29
Female (N=190)	13	56	32
Age:			
18-29 (N=111)	12	67	22
30-39 (N=99)	14	59	27
40-55 (N=111)	18	43	39
Over 55 (N=52)	15	50	35
Income:			
$15,000 and under (N=129)	14	64	22
Over $15,000 (N=240)	15	50	34
Occupation:			
Professional and Business (N=113)	13	63	24
Manual (N=249)	16	51	33

PAGE, ARIZONA

DO YOU APPROVE OR DISAPPROVE OF OUTSIDE INTERESTS INVESTING MONEY IN THIS COMMUNITY?

	Approve	Disapprove	Don't Know
Total	81%	8%	11%
Sex:			
Male (N=184)	83	8	10
Female (N=190)	80	8	12
Age:			
18-29 (N=111)	81	8	11
30-39 (N-99)	80	9	11
40-55 (N=111)	83	8	9
Over 55 (N=52)	81	4	15
Income:			
$15,000 and under (N=129)	78	5	18
Over $15,000 (N=240)	83	9	8
Occupation:			
Professional and Business (N=113)	91	5	4
Manual (N=249)	78	9	13

DO YOU FAVOR OR OPPOSE THE RECRUITMENT OF MINORITY GROUPS (SUCH AS INDIANS) TO WORK IN LOCAL POWER PLANTS?

	Favor	Oppose	Don't Know
Total	85%	12%	4%
Sex:			
Male (N=184)	84	14	2
Female (N=190)	85	10	5
Age:			
18-29 (N=111)	86	12	2
30-39 (N=99)	83	12	5
40-55 (N=111)	85	11	4
Over 55 (N=52)	85	12	4
Income:			
$1,5000 and under (N=129)	81	12	6
Over $15,000 (N=240)	87	11	2
Occupation:			
Professional and Business (N=113)	88	9	4
Manual (N=249)	84	12	4

PAGE, ARIZONA

DO YOU ANTICIPATE CHANGING YOUR EMPLOYMENT IF THIS COMMUNITY GROWS SUBSTANTIALLY?

	Yes	No	Don't Know
Total	8%	91%	1%
Sex:			
Male (N=184)	9	90	1
Female (N=190)	7	92	1
Age:			
18-29 (N=111)	12	86	3
30-39 (N=99)	9	91	0
40-55 (N=111)	6	94	0
Over 55 (N=52)	4	96	0
Income:			
$15,000 and under (N=129)	9	89	2
Over $15,000 (N=240)	8	92	0
Occupation:			
Professional and Business (N=113)	11	89	0
Manual (N=249)	8	91	1

WHICH DO YOU BELIEVE IS MOST IMPORTANT IN THIS AREA?

	Economic Development	Environmental Conservation	Both	Don't Know
Total	40%	25%	32%	3%
Sex:				
Male (N=184)	46	25	29	1
Female (N=190)	34	25	35	6
Age:				
18-29 (N=111)	27	44	23	4
30-39 (N=99)	39	25	32	3
40-55 (N=111)	46	12	40	3
Over 55 (N=52)	54	12	31	4
Income:				
$15,000 and under (N=129)	32	30	30	8
Over $15,000 (N=240)	44	22	33	1
Occupation:				
Professional and Business (N=113)	35	24	38	3
Manual (N=249)	42	25	29	4

APPENDIX III-I

Air Quality

Radioactive Nuclides

APPENDIX III - 1

Air Quality

Kaiparowits Plateau impact area

Radioactive Nuclides

Total radioactivity concentration of ash would be approximately 8.4 picocuries per gram (pCi/g). Assuming the average grade coal contains 9.2 percent ash, and that all radioactivity in the analysis is associated with ash. Particulate emissions from the stacks are estimated at approximately 12.2 tons per day with 99.5 percent particulate removal efficiency resulting in approximately 93 x 10^6 pCi/day leaving the stacks. Plant engineering data indicate that flue gas flow rate per unit would be 2.4 x 10^6 cfm or a total of 9.6 x 10^6 cfm for all four units. The daily flow rate would be 391 x 10^6m3/day resulting in an emission concentration for thorium plus radium activity of approximately 0.24 pCi/m^3.

APPENDIX III-2

Air Quality

Field Tracer Plume Simulation Study

APPENDIX III - 2

Air Quality

Kaiparowits Plateau impact area

Field tracer plume simulation study

Oil fog simulation trials were conducted at five potential sites between November 9 and 17, 1973 (Spangler et al. 1973). Sites included Fourmile Bench (6,100 feet MSL), Horse Flat (5,900 feet MSL), Dry Bench (5,200 feet MSL), John Henry Bench (5,000 feet MSL), and Nipple Bench (5,200 feet MSL). Meteorological observations consisted of vertical temperature soundings from aircraft, vertical wind profiles (pibals) for each site at four hour intervals between 0300 and 1900 MST, and simultaneous pibals at the Page airport.

Smoke releases were made at dawn, mid-morning, and early afternoon over the site at calculated effective stack height.

Three smoke release days were under neutral to moderately stable conditions (TVA criteria). One smoke release day was under stable conditions. During the stable condition release, the plume was observed to move in a straight line toward the northeast with little vertical movement, and was visible for 20 miles downwind. The Fourmile Bench plume followed the terrain up and over the Kaiparowits Plateau and then descended into the valley north of the plateau where it rapidly dispersed. Ten smoke releases were made over Fourmile Bench and twenty releases were made during the entire study.

During May 1974, studies were conducted including oil fog-FP tracer releases (Spangler et al., 1974). Ten tracer releases were made, seven at Fourmile Bench and three at Nipple Bench. Oil fog was released simultaneously with the FP tracer releases at calculated effective stack height for quantitive dispersion evaluations and air-mass flow visualization. Turbulence data were gathered on one Fourmile Bench flight and three Nipple Bench flights. At the beginning of each flight, a vertical temperature and turbulence sounding was usually taken. All tracer releases at Fourmile Bench were made during neutral (Category D) stability conditions.

The November studies indicated that atmospheric turbulence intensities varied from light to moderate. Generally, lowest turbulence values were found during early morning hours, increasing in intensity during the day. Comparison with other sites in the area strongly suggested that turbulence levels at plume altitude were consistently stronger over Fourmile Bench than over the other locations.

For air mass stability conditions classified as neutral (Pasquill D) over flat terrain, the observed dispersion characteristics at Fourmile Bench varied between those expected for slightly unstable (Pasquill C) to very unstable (Pasquill A) atmospheric conditions. For a slightly stable air mass (Pasquill E), the observed dispersion characteristics were close to slightly unstable (Pasquill C).

Visual and quantitative measurements of smoke tracer plumes indicated that stack effluents emitted from the Fourmile Bench site should not encounter adverse dispersion effects while being transported to the north and northeast.

Terrain induced turbulence will result in significantly faster dilution of stack effluents than was predicted with standard dispersion parameters applicable for flat terrain.

Fluorescent particle tracer impact, when equated to equivalent hourly or three-hour SO_2 concentrations, was less than 0.02 ppm SO_2 for slightly stable and most neutral and looping plume conditions. During one of the tracer releases, the maximum one-hour equivalent SO_2 concentration was less than 0.02 ppm from a looping plume condition. Maximum SO_2 concentration was less than 0.03 ppm under slightly stable, coning and looping plume conditions.

Visual tracking of oil fog plume confirmed the general areas of potential impact indicated by FP tracer patterns.

Aerial plume measurements made under predominately neutral conditions showed that relative plume centerline values were consistent or lower than values predicted with the Gaussian Plume Model.

Analysis of wind measurements taken simultaneously at the Page airport and Fourmile Bench showed a relatively good correlation between the two at expected plume altitude, with the best correlation occuring during afternoon hours. Recognizing certain constraints such as low pressure systems, low-level drainage winds at Page, passage of fronts, etc., Page Airport pibal winds could be used to typify plume transport over Fourmile Bench.

APPENDIX III - 3

Air Quality

Comparison of Plume Dispersion Models

APPENDIX III - 3

Air Quality

Kaiparowits Plateau impact area

Comparison of plume dispersion models

Field tracer data obtained during November 1973 and May 1974 were used for comparisons of several dispersion modeling techniques to predict potential impact of the power plant on air quality, utilizing available information of the meteorological characteristics of the site, (Intera, 1974). Four dispersion modeling approaches were tested against the fluorescent particle tracer data obtained by North American Weather Consultants in May 1974 (Spangler et al., 1974). The models tested were:

1. The Gaussian Model and Assumptions used by NOAA in the Southwest Energy Study (SWES Appendix E. 1972).
2. The Valley Model under the Name C4M3D developed by EPA.
3. Tennessee Valley Authority (TVA) Model (Montgomery et al., 1973).
4. The Intercomp Model (Intera, 1974).

The model comparison study considered two tracer releases at Fourmile Bench and two at Nipple Bench. The ability of these models to simulate field experimental results was the criterion for selection of a model for impact predictions. Ground level dispersion patterns were predicted by each model utilizing meteorological conditions that occurred during tracer releases. Meteorological parameters were then varied within the model limits to obtain the best simulation of dispersion patterns.

The study concluded that the Intercomp Model was slightly more accurate in simulating tracer data under neutral and unstable situations. In a previous comparison study of the NOAA Gaussian Model, the C4M3D Model and the Intercomp Model, under predictive situations, it was concluded that the Intercomp Model gave accuracy in stable flows in irregular terrain comparable to that obtained by by Gaussian Models in flat terrain within a factor of 2.5 (Evaluation of Air Pollution Dispersion Models 1974).

The Intercomp Model was then used to predict the impact of plant emissions on air quality, utilizing assumptions concerning coal quality, station load, emission control, and meteorological conditions.

APPENDIX III - 4

Air Quality

Visibility Study

APPENDIX III - 4

Air Quality

Kaiparowits Pleateau impact area

Visibility study

Stack emissions can include soot and fly ash as well as particles formed by catalyzed or photochemical reactions in the atmosphere. For coal burning power plants, the important reactions are conversion of sulfur dioxide to sulfates and nitrogen oxides to nitrates.

Size distribution is one of the main properties of these aerosols affecting visibility, although aerosol concentration and physical characteristics are also involved. Investigators have determined that 90 percent of visibility reduction is caused by particles in the 0.1 to 1.0 micron (um) range (USDAEW, 1969; Charlson, 1969; Corn, 1968; Shannon, 1971; Faith and Atkieson, 1972; Rich, 1971).

Hill and other investigators have shown that a significant contribution to light scattering by fly ash, soot, and ammonium sulfate-nitrate particles is made by particles up to 2-5 um and by soil dust particles up to 5-8 um (Hill et al., 1973a; Hill et al., 1973b).

The size effect is primarily due to scattering of light, reducing object contrast ultimately to a point where the object can no longer be distinguished from its background. Relative humidity can also play a crucial role in visibility affected by particles, particularly at relative humidities above 70 percent.

Chemical composition of particulates affect their refractive index and light absorption properties but these properties are of secondary importance to visibility reduction from light scattering.

In the following study, Bechtel Power Corporation (1974) concluded that in the Kaiparowits region, sulfur dioxide is not expected to have a direct effect on visibility; however, conversion of sulfur dioxide to particulates will have an impact. In addition, the degree of brown discoloration in the plume will be proportional to the concentration of NO_2.

Effect of sulfur oxides on visibility

Sulfur dioxide (SO_2) is a colorless gas and does not directly affect visibility. SO_2 can however, be oxidized to sulfur trioxide (SO_3) which can then combine with atmospheric water to form a sulfuric acid mist. Johnstone and Coughanour (1958) have shown that SO_2 is oxidized slowly in the gas phase in the atmosphere but after absorption on liquid droplets it will react much more rapidly. Some sulfur trioxide (about one to five percent of total sulfur) usually accompanies sulfur dioxide in flue gases. Additional SO_3 is produced in the stack plume in two other ways. The first is a catalyzed reaction that is dominant for relative humidity above approximately 90 percent; and dependent upon SO_2 concentration. The reaction rate decreases very rapidly as the plume is diluted (Wayne, 1973). The second reaction is a photochemical process and appears to be independent of concentration or humidity.

Combining of SO_3 with other materials such as water and ammonia to form sulfate particles, and with water to form sulfuric acid mist, add to the aerosol mass concentration of the atmosphere which in turn has a potential effect on visibility. The important factors affecting the conversion rate are relative humidity, concentration of catalytic metals, intensity of sunlight, plume altitude and sulfur dioxide concentration. From an assessment of these factors, as they apply to emission from the proposed Kaiparowits plant and meteorological conditions in the area surrounding the proposed site, Bechtel estimated that four percent of the sulfur dioxide leaving the plant would be converted to sulfate (Bechtel 1974). The four percent conversion rate is based on the assumption of a 90 percent relative humidity condition that occurs less than 20 percent of the time at the site.

For relative humidity less than 90 percent, the sulfate conversion rate would be less than four percent.

Predictions of impact on visibility

The relationship between visibility and aerosol mass concentration can be approximated by the equation (Charlson 1969):

$$LV = \frac{1120}{C}$$

Where: LV = Local Visual range

LV can be interpreted as standard visual range when the aerosol concentration is homogeneous along the observer's line of sight.

C = aerosol mass concentration

Using this relationship, Bechtel Corporation used derivations of a mathematical model (Turner, 1970) to explore several different lines of sight relative to the plume and determine the concentration of aerosols along those lines and resulting visual ranges. Visual range was defined as the distance the apparent contrast of an object is reduced to two percent of its inherent value. Lines of sight considered were at ground level under the centerline of the plume both toward and away from the plant and perpendicular to the plume at different distances down-wind from the plant.

The following assumptions were made:

1. Gaussian plume dispersion.
2. Four percent of releasedd SO_2 immediately converted to aerosols.
3. Negligible conversion of NO_X to aerosols.
4. A background aerosol concentration yielding an average visual range of 70 miles.
5. Neutral meteorological conditions.
6. Unidirectional wind speed of 2.5 meters per second (5.6 mph).
7. $LV = 1120/C$

The study concluded that it would be necessary for an observer to look directly along the plume centerline in the direction of the station before any visibility reduction would occur. Visibility reductions in these cases were approximately 10 to 20 miles,, (Illustrations 1 and 2). Visibility reduction from other lines of sight was insignificant. Conclusions were based on assumed meteorological conditions (high humidity, wind, and stability persisting for several hours) which were estimated to have a simultaneous occurrence probability of approximately five percent.

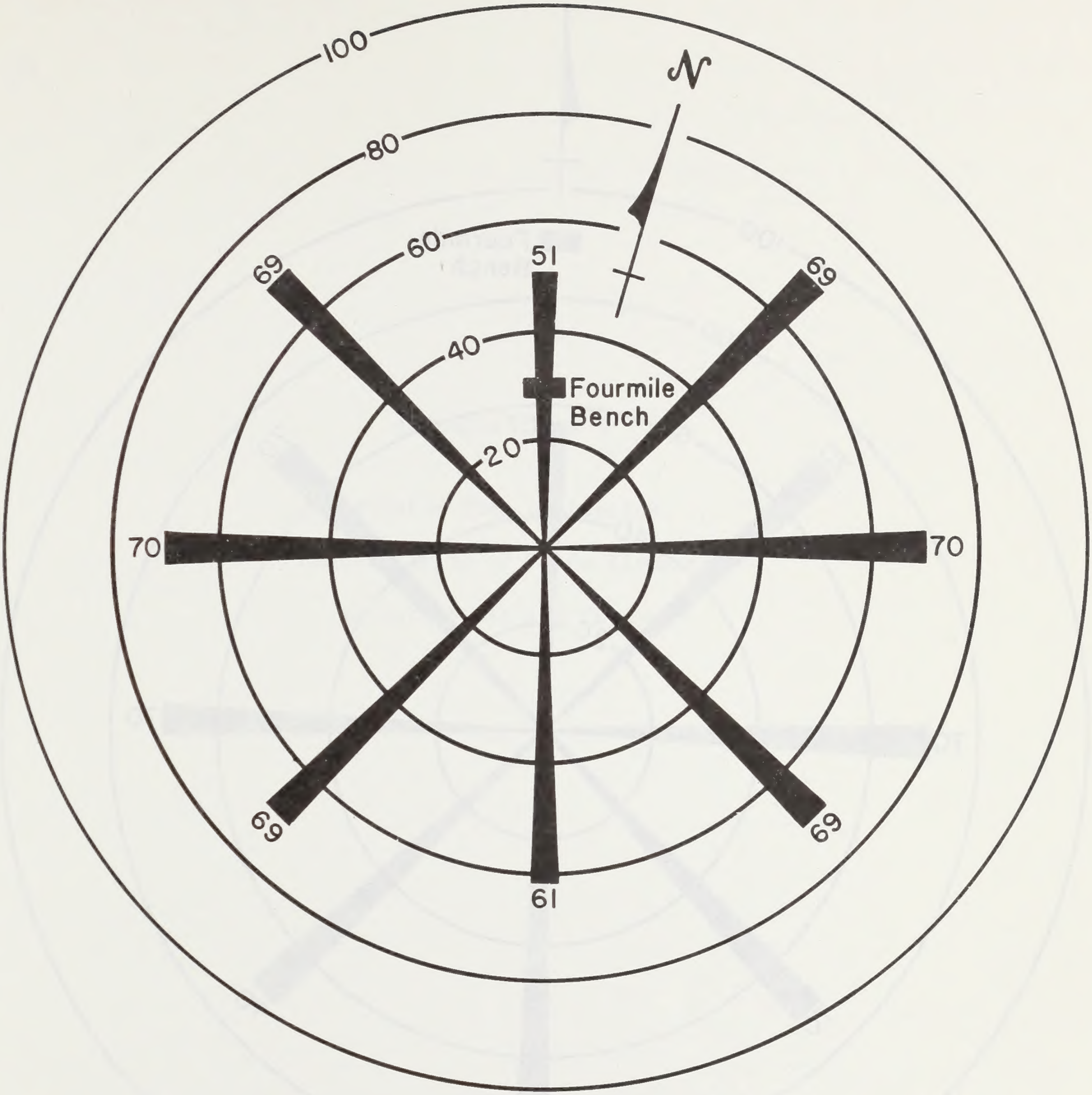
Nitrogen dioxide and brown discoloration

When fossil fuel is burned under high temperature conditions with air as an oxidant, a portion of the nitrogen in the air is oxidized to nitric oxide (NO) which is colorless and odorless. A comparatively small amount (about 5.0 percent) becomes nitrogen dioxide (NO_2). When the NO is released to the ambient air, approximately 10 percent is oxidized to NO_2. After the concentration of NO reaches one ppm in the atmosphere, a photochemical reaction takes place that is dependent on sunlight, ozone, hydrocarbons, and the total concentration of NO. The production rate of NO_2 is reduced by atmospheric dilution of NO below one ppm, and by the absence of ozone or hydrocarbons.

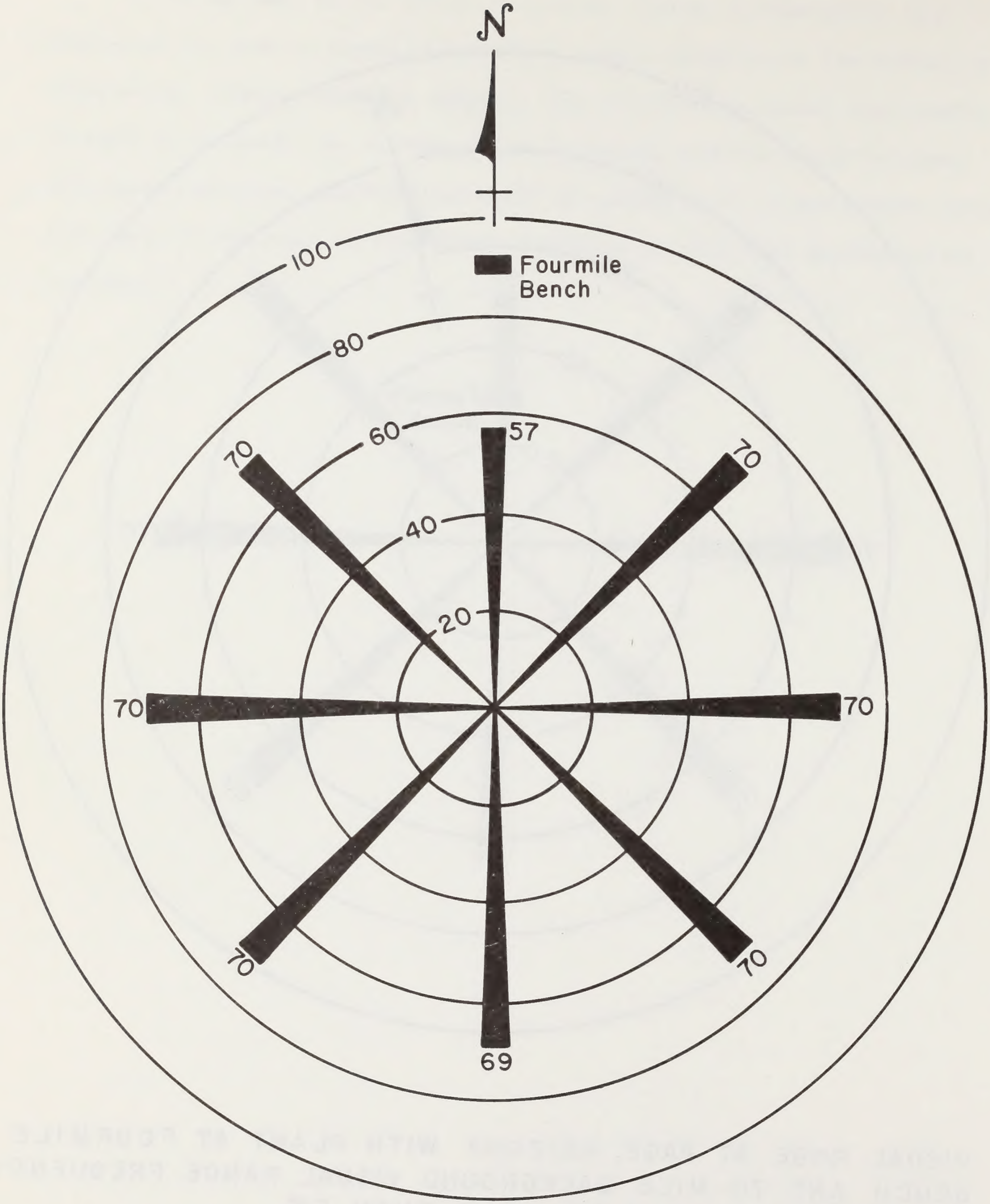
It is possible that NO_2 can be further oxidized to N_2O_5, which with water vapor forms nitric acid (HNO_3). This, in turn, reacts with various metal salts yielding a particulate phase, metal nitrate (Faith and Atckinson, 1972). Wayne (1973) believes this process to be negligible at Kaiparowits.

Nitrogen dioxide remaining in the atmosphere absorbs bluegreen light, giving the atmosphere a yellow-brown discoloration proportional to the NO_2 concentrations. The rate of NO_2 production by a fossil fuel burning power plant and its rate of production in the atmosphere downwind of the power plant are not well known. Brown discoloration does, however, have the potential for degradation of visual environment.

An estimate of the effect of nitrogen dioxide on atmospheric discoloration was made by Bechtel Corporation using a variation of the visibility calculation. Their conclusion indicate, "the calculations showed that usually it would be necessary for an observer to be looking directly along the plume axis before any brown discoloration would be noticeable." It was further stated that "most of the time, no discoloration will be apparent when looking across the plume."



VISUAL ROSE AT PAGE, ARIZONA WITH PLANT AT FOURMILE BENCH AND 70 MILE BACKGROUND VISUAL RANGE. FREQUENCY OF OCCURRENCE WILL BE LESS THAN 5%.



VISUAL ROSE AT GRAND CANYON WITH PLANT AT FOURMILE BENCH AND 70 MILE BACKGROUND VISUAL RANGE. FREQUENCY OF OCCURRENCE WILL BE LESS THAN 5%.

ILLUSTRATION 2

APPENDIX III - 5

Estimated Post Combustion Concentration of Trace Elements in Bottom Ash and Fly Ash

FIGURE 1

Air Quality

Kaiparowits Plateau impact area

Estimated Post Combustion Concentration of Trace Elements in Bottom Ash and Fly Ash

	Analysis in Coal or ash (ppm)		Fractionation				Precipitator Capture	Release From Stack	
			Bottom Ash		Fly Ash				
Element	Coal	Ash^{b}	ppm	lbs/day	ppm	lbs/day	lbs/day	lbs/day	
Antimony	.13 ± .07^{b}		0	0	1.8	9	8.9	0.1	
Arsenic	.83± .81^{a} .90± .20^{b}		0	0	8.8	43	42	14	Assumes a 25% fractional release to the atmosphere as vapor (Williams and Walther 1974)
Barium		2290± 2055	2290	2800	2290	11144	11088	56	
Beryllium	.48± .19^{a}	3.40± 3.30	4	5	4	20	19.9	0.1	
Boron		1400± 834	1400	1680	1400	6686	6653	33	
Cadmium	.87± .73		9	11	9	46	45.8	0.2	
Cerium	Not detected								
Chromium	3.6 ± 2.3^{a}	62± 11	0	0	61	298	296	2	
Cobalt		12± 10	12	15	12	58	57.7	0.3	
Copper		80± 11	0	0	98	478	472	2	
Fluorine	54 ± 42^{a}	120± 23	0	0	594	2900	2886	2914	Assumes a 50% fractional release to atmosphere as gas (Williams and Walther 1974)
Gallium		26± 5	0	0	32	155	154	1	
Germanium	Below limits of detection								
Lanthanium	Below limits of detection								
Lead		38± 11	0	0	47	227	226	1	
Lithium		72± 26	72	88	72	353	351	2	
Manganese	6± 2^{a}	210±164		166	136	661	658	3	
Mercury	.06±.07 .04±.01		0	0	.002	.01	0	4	Assumes a 96% fractional release to the atmosphere as vapor (Southwest Energy Study 1972 Williams and Walther 1974)
Molybdenum		6± 3	0	0	7	36	35.8	0.2	
Nickel	5± 1^{a}	34± 21	0	0	55	269	268	1	
Selenium	4± 4 1.98± .58		0	0	31	150	149	50	Assumes a 25% fractional release to atmosphere as vapor (Williams and Walther 1974)
Strontium		560± 261	560	683	560	2719	2705	14	
Scandium		14± 2	14	17	14	68	67.7	0.3	
Tellurium	Below limits of detection								
Thallium		.34± .12	.34	.41	.34	1.66	1.65	.01	
Titanium		3000± 1	3000	3660	3000	14567	14494	73	
Uranium	.66± .36^{b}		7	9	7	35	34.8	0.2	
Vanadium	8± 1	92± 35	0	0	111	537	534	3	
Yitrium		44± 24	44	54	44	215	214	1	
Ytterbium		4± 1	4	5	4	19	18.9	.1	
Zinc		64± 70	0	0	78	382	380	2	
Zirconium		150± 1	150	183	150	732	728	4	

[a] Data from report to Arizona Public Service and Southern California Resource Data 1974.
[b] Data from Southwest Energy Study, Appendix J., U.S. Bureau of Geological Survey January 1972.

APPENDIX III - 6

Impacts of Proposed Action on Soils

APPENDIX III - 6

Soils

Kaiparowits Plateau Impact Area

Impacts of proposed actions on soils

Introduction

All data developed to identify the various effects of power plant construction, mine construction and road construction are contained in this section. A brief explanation is given for each table and figure, describing methods used for their development. A summary of the effects are given in the main report in Chapter III, Impacts on Soil.

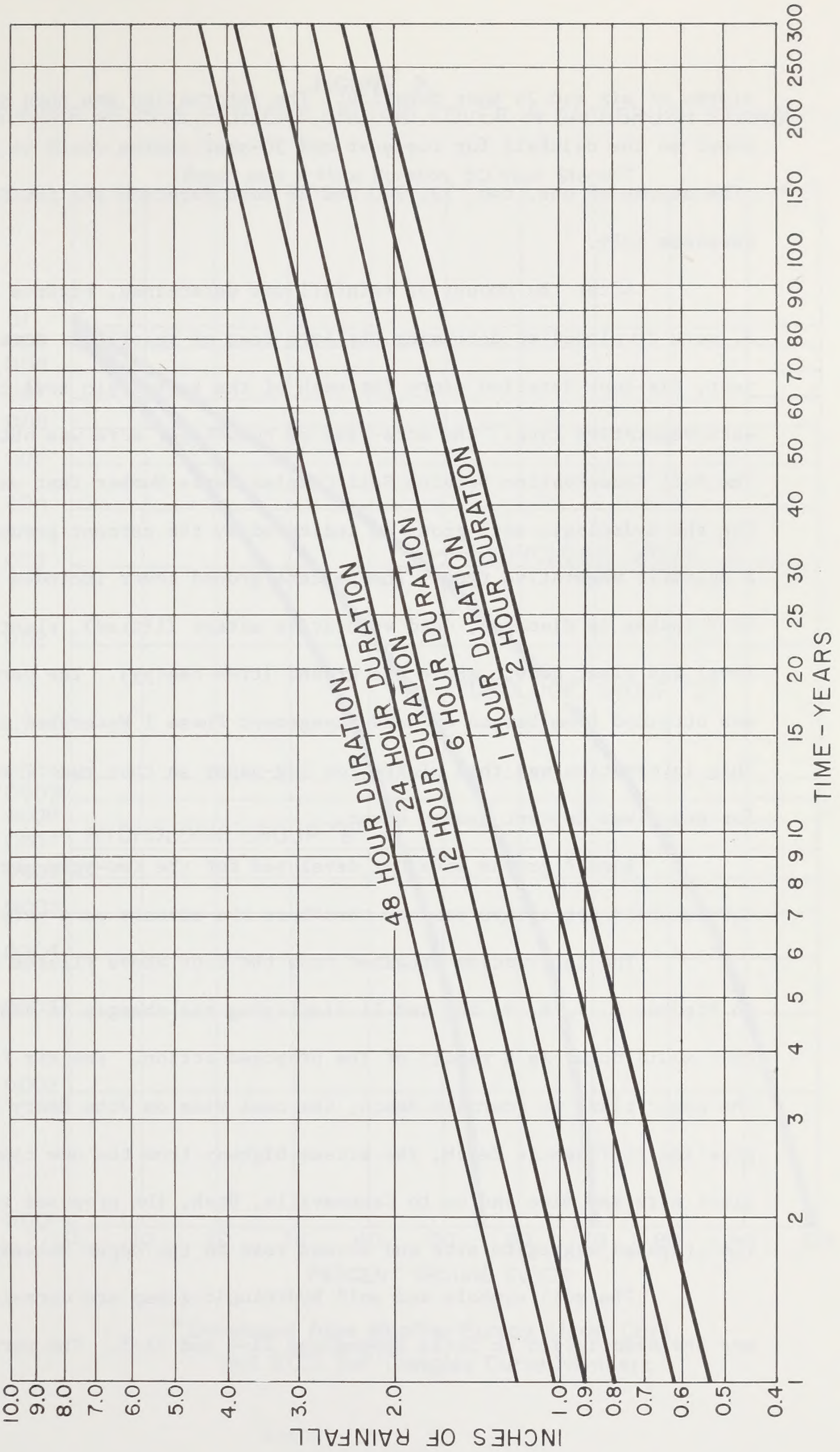
Description

The first information needed for evaluating the effects of erosion was to the intensity and amount of rainstorms. The storms chosen were of a six-hour duration occurring on the average once every two years and once every 50 years. The six-hour duration was chosen because of the high intensity that usually causes runoff. The two year frequency storm was used to illustrate the most common storm that would occur during the project life that would produc runoff. The 50-year frequency storm was used to illustrate the maximum effects of a storm that could occur during the life of the project.

The inches of rainfall for the two-year and 50-year storms, six-hour duration, were obtained from Figure 1, Storm Duration Versus Recurrence in Years. The two-year storm yields 0.9 of an inch, whereas the 50-year storm yields 1.9 inches. Figure 2 was developed using information obtained from precipitation-frequency maps for Utah. These maps were prepared by the Special Studies Branch, Office of Hydrology, Weather Bureau, and published July, 1968. Information contained on the maps consisted of lines of equal rainfall (isopluvial) for various

FIGURE I

STORM DURATION VERSUS RECURRENCE IN YEARS



storms of six and 24 hour duration. The information was then plotted on log-paper so the rainfall for two-year and 50-year storms could be identified. The storms of one, two, 12, 24, and 48 hour duration are for illustrative purposes only.

After the amount of rainfall was determined, Figures 2, 3, 4, and 5, were developed to determine the acre-feet of runoff per acre during a 50-year, six-hour duration storm for each of the hydrologic soil groups within each vegetative type. The acre-feet of runoff per acre was obtained by using the Soil Conservation Service Soil Complex Curve Number that was representative for the hydrologic soil group as indicated by the percent ground cover within a specific vegetative type. The percent ground cover includes rock from 1/4 to 2 inches in diameter, dead vegetative matter (litter), plant growth at ground level and plant growth above the ground (tree canopy). The percent ground cover was obtained from Bureau of Land Management Phase 1 Watershed inventories. This information was then plotted on log-paper so that runoff could be determined for any given percent ground cover.

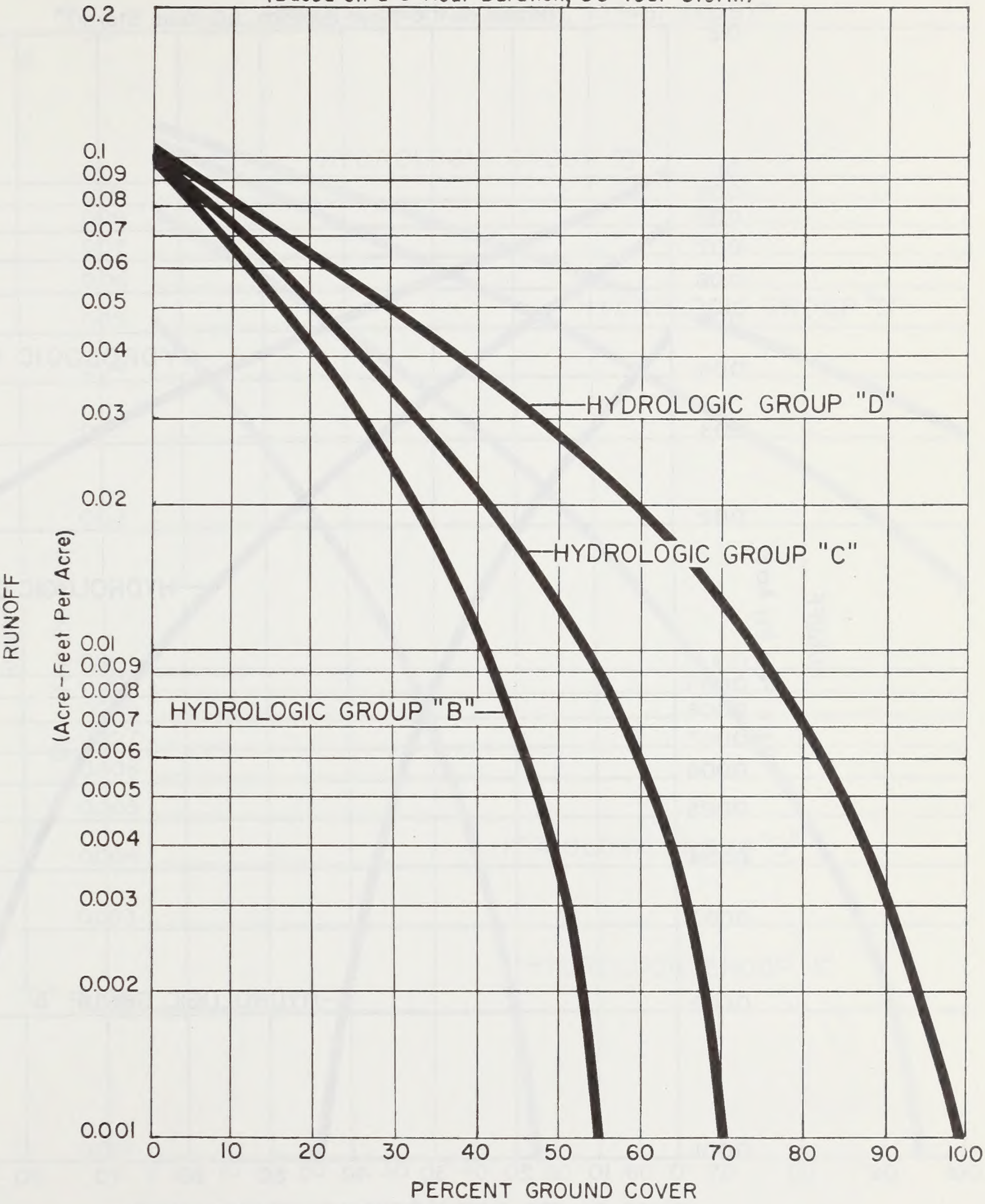
Runoff graphs were not developed for the two-year storms because their curves would not always produce runoff as the amounts were very small.

The information obtained from the four above figures was then placed in Figures 6, 7, 8, 9, 10, and 11 displaying the changes in runoff and erosion that would occur as a result of the proposed action. The six figures represent the power plant on Fourmile Bench, the coal mine on John Henry Bench, the water pipeline to Fourmile Bench, the access highway from the new town to the proposed plant site and mine and on to Cannonville, Utah, the proposed townsite, and the proposed aggregate site and access road on the Upper Wahweap.

The soil symbols and soil hydrologic group are correlated to the soils map and description in Soils Appendices II-4 and II-5. The percent ground

FIGURE 2
RUNOFF VERSUS PERCENT GROUND COVER IN SAGEBRUSH STAND

(Based on a 6-Hour Duration, 50-Year Storm)*

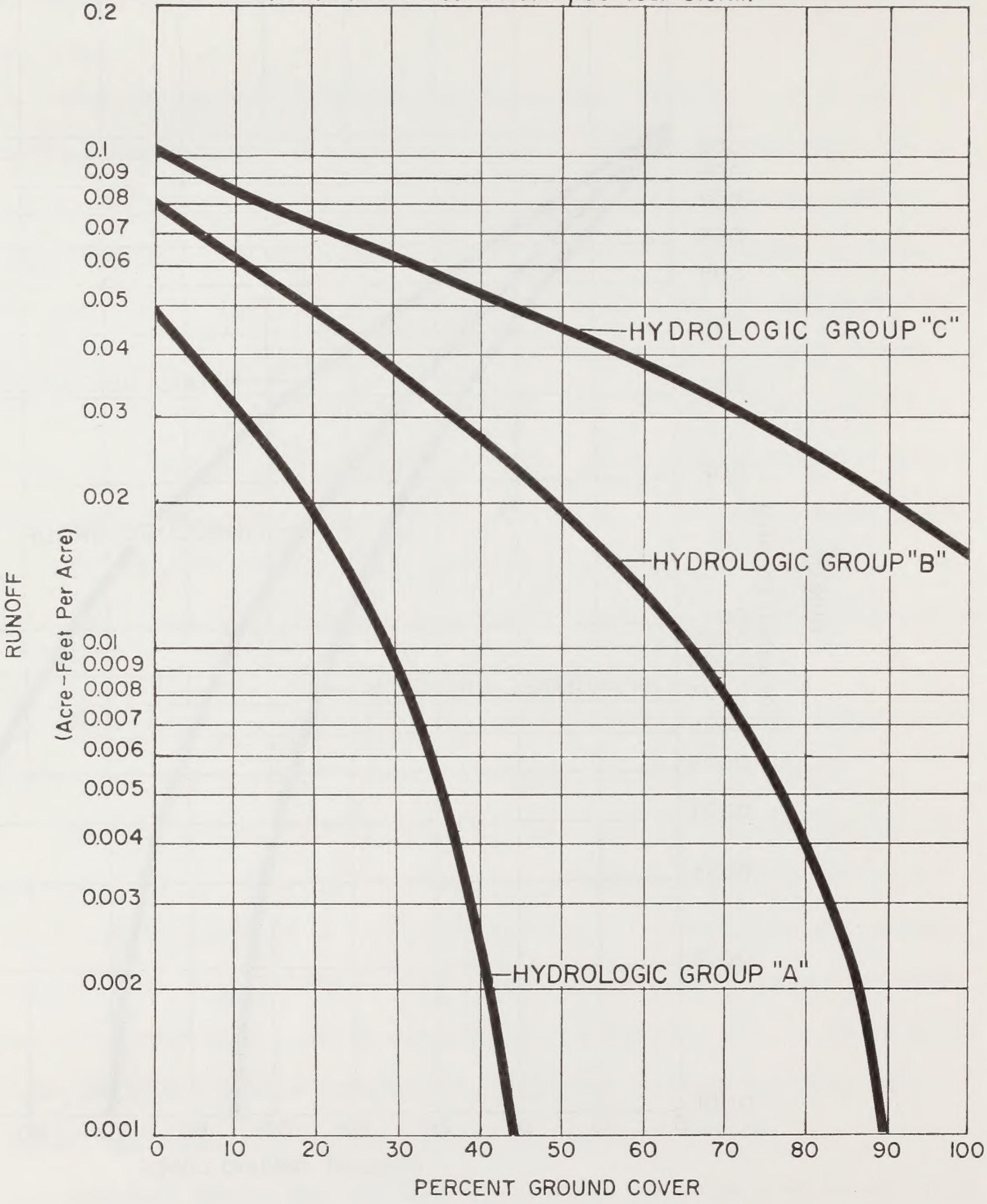


*Developed from Weather Bureau Storm Data
and S.C.S. Soil Complex Curve Numbers

FIGURE 3

RUNOFF VERSUS PERCENT GROUND COVER IN A GRASSLAND STAND

(Based on a 6-Hour Duration, 50-Year Storm)*

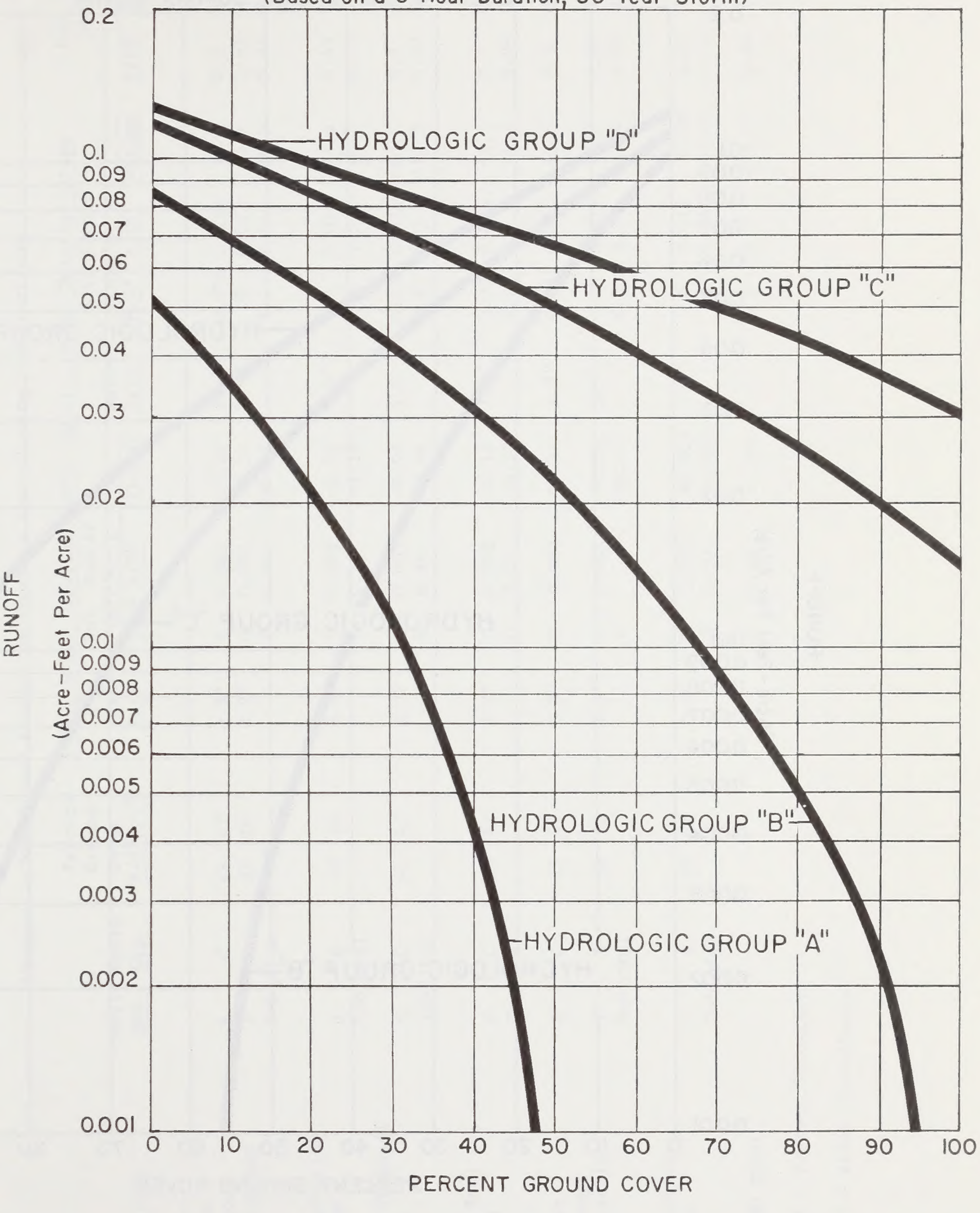


*Developed from Weather Bureau Storm Data
and S.C.S. Soil Complex Curve Numbers

FIGURE 4

RUNOFF VERSUS PERCENT GROUND COVER IN SALTBUSH, DESERT SHRUB, SALINE FLATS AND WASTE AREAS

(Based on a 6-Hour Duration, 50-Year Storm)*

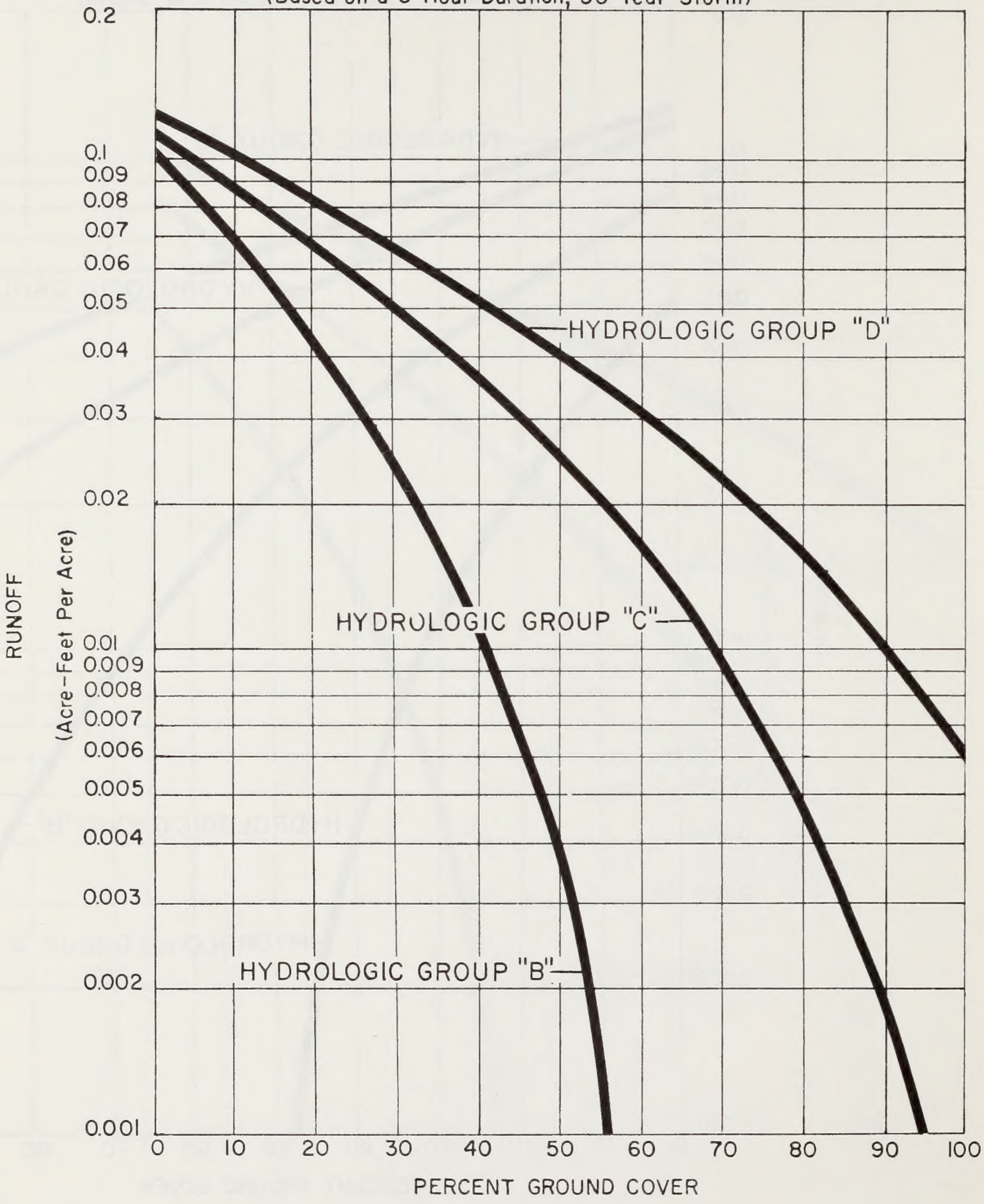


* Developed from Weather Bureau Storm Data and S.C.S. Soil Complex Curve Numbers

FIGURE 5

RUNOFF VERSUS PERCENT GROUND COVER IN A PINYON-JUNIPER STAND

(Based on a 6-Hour Duration, 50-Year Storm)*



* Developed from Weather Bureau Storm Data and S.C.S. Soil Complex Curve Numbers

FIGURE 6

Changes in Runoff and Erosion on Fourmile Bench During Construction

Facility	Soil Sym.	Hydro Grp.	Percent Ground Cover P/S[a]	A/C[b]	2 yr., 6-hr. Duration Storm				50 yr., 6-hr. Duration Storm				Est. Annual Sediment Yield (a/f/Mi.^{2})		
					Rain-Fall	Est. Runoff (a/f/Ac.) P/S[a]	A/D[b]	Change	Rain-Fall	Est. Runoff (a/f/Ac.) P/S[a]	A/D[b]	Change	P/S[a]	A/D[b]	Change
Power Block & Support Facilities	E	C	65	42	0.9"	0	0.002	+0.28	1.9"	0.012	0.034	+3.1	0.5	0.7	+0.04
	I	B	58	28	0.9"	0	0.001	+0.14	1.9"	0	0.025	+3.5	0.45	0.62	+0.04
	Subtotal					0	0.42	+0.42		1.7	8.3	+6.6	0.21	0.29	0.08
Evaporation Ponds	I	B	58	28	0.9"	0	0.001	+0.18	1.9"	0	0.025	+4.5	0.45	0.62	+0.04
	Subtotal					0	0.18	+0.18		0	4.5	+4.5	0.13	0.17	+0.04
Ash Disposal Area	E	C	65	42	0.9"	0	0.002	+0.96	1.9	0.012	0.034	+10.5	0.5	0.7	+0.15
	Subtotal					0	0.96	+0.96		5.8	16.3	+10.5	0.38	0.53	+0.15
Ash Haul Road	E	C	65	42	0.9"	0	0.002	+0.10	1.9"	0.012	0.034	+1.1	0.5	0.7	+0.02
	Subtotal					0	0.10	+0.10		0.6	1.7	+1.1	0.04	0.06	+0.02
Water Storage Reservoir	E	C	65	42	0.9"	0	0.002	+0.14	1.9"	0.012	0.034	+1.5	0.5	0.7	+0.02
	I	B	58	28	0.9"	0	0.001	+0.04	1.9"	0	0.025	+0.9	0.45	0.62	+0.01
	Subtotal					0		+0.18		0.8	3.2	+2.4	0.08	0.11	+0.03
Retention Pond	I	B	58	28	0.9"	0	0.001	+0.002	1.9"	0	0.025	+0.06	0.45	0.62	-----
	Subtotal					0	0.002	+0.002		0	0.06	+0.06	----	----	-----
GRAND TOTAL						0	1.84	+1.84		8.9	34.1	+25.2	0.84	1.16	+0.32

[a] P/A = Present Situation

[b] A/D = After Disturbance

FIGURE 7

Changes in Runoff and Erosion Along Water Pipeline to Fourmile Bench During Construction

			Percent Ground Cover		2Yr., 6-hr. Duration Storm				50 Yr., 6-hr. Duration Storm				Est. Annual Sediment Yield (a/f/Mi.^{2})		
						Est. Runoff (a/f/Ac.)				Est. Runoff (a/f/Ac.)					
Facility	Soil Sym	Hydro Grp.	P/C[a]	A/C[b]	Rain-Fall	P/S[a]	A/D[b]	Change	Rain-Fall	P/S[a]	A/D[b]	Change	P/S[a]	A/D[b]	Change
Pipeline from Lake Powell to Fourmile Bench	I	B	30	16	0.9"	0.002	0.008	+0.11	1.9"	0.011	0.025	+0.26	0.45	0.54	+0.003
	VV	D	--	--	0.9"	0.014	0.018	+0.03	1.9"	0.069	0.078	+0.07	----	----	------
	KK	C	82	72	0.9"	0	0	0	1.9"	0.025	0.031	+0.32	0.65	0.69	+0.003
	WW	D	--	--	0.9"	0.014	0.018	+0.08	1.9"	0.069	0.078	+0.17	----	----	------
	K	B	67	49	0.9"	0	0	0	1.9"	0.010	0.023	+0.84	0.45	0.54	+0.009
	T	C	24	9	0.9"	0.014	0.024	+0.76	1.9"	0.077	0.100	+1.74	0.55	0.62	+0.008
	I	B	28	8	0.9"	0.004	0.012	+0.42	1.9"	0.012	0.035	+1.22	0.45	0.56	+0.009
	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+0.33	0.45	0.54	+0.005
	UU	D	81	76	0.9"	0.004	0.005	+0.02	1.9"	0.042	0.045	+0.06	1.20	1.30	+0.003
	I	B	58	28	0.9"	0	0.001	+0.10	1.9"	0	0.025	+2.46	0.65	0.69	+0.006
	Subtotal					1.76	3.28	+1.52		11.36	18.83	7.47	0.37	0.41	+0.04
Pump Station (Lake Powell)	I	B	30	16	0.9"	0.002	0.008	+0.006	1.9"	0.011	0.025	+0.01	0.45	0.54	-----
						0.002	0.008	+0.006		0.011	0.025	+0.01	----	----	-----
Pump Station (Nipple Bench)	K	B	67	49	0.9"	0	0	0	1.9"	0.010	0.023	+0.17	0.45	0.54	+0.002
						0	0	0		0.13	0.30	+0.17	0.009	0.911	+0.002
Maintenance Road	WW	D	--	--	0.9"	0.014	0.018	+0.11	1.9"	0.069	0.078	+0.25	----	----	------
	KK	C	82	72	0.9"	0	0	0	1.9"	0.025	0.031	+0.13	0.65	0.69	+0.001
	UU	D	81	76	0.9"	0.004	0.005	+0.01	1.9"	0.042	0.045	+0.03	1.20	1.30	+0.002
	T	C	49	37	0.9"	0.006	0.009	+0.04	1.9"	0.050	0.062	+0.14	0.55	0.60	+0.001
	T	C	29	9	0.9"	0.004	0.024	+0.24	1.9"	0.077	0.100	+0.28	0.55	0.62	+0.001
	Subtotal					0.55	0.95	0.40		4.46	5.29	+0.83	0.07	0.08	+.01
GRAND TOTAL						2.31	4.24	+1.93		15.96	24.44	8.48	0.45	0.50	+0.05

[a] P/S = Present Situation
[b] A/D = After Disturbance

FIGURE 8

Changes in Runoff and Erosion on John Henry Bench During Construction

Facility	Soil Sym	Hydro Grp.	Percent Ground Cover P/S[a]	A/C[b]	2 Yr., 6-Hr. Duration Storm Rain-Fall	Est. Runoff (a/f/ac.) P/S[a]	A/D[b]	Change	50 Yr., 6-hr. Duration Storm Rain-Fall	Est. Runoff (a/f/ac.) P/S[a]	A/D[b]	Change	Est. Annual Sediment Yield (a/f/Mi.^{2}) P/S[a]	A/D[b]	Change
Administ.	DD	B	33	11	0.9"	0.002	0.011	+0.45	1.9"	0.036	0.066	+1.5	0.50	0.64	+0.01
Buildings	Subtotal					0.10	0.55	+0.45	1.9"	1.80	3.30	+1.5	0.04	0.05	+0.01
Washery	DO	B	33	11	0.9"	0.002	0.011	+0.45	1.9"	0.036	0.066	+1.5	0.50	0.64	+0.01
& Silos	Subtotal					0.10	0.55	+0.45		1.80	3.30	+1.5	0.04	0.05	+0.01
Mine Port-	C	B	77	44	0.9"	0	0	0	1.9"	0	0.001	+0.02	0.45	0.56	+0.005
als &	DD	B	33	11	0.9"	0.002	0.011	+0.65	1.9"	0.036	0.066	+2.17	0.50	0.64	+0.016
Vent Fans	Subtotal					0.14	0.79	+0.65		2.59	4.78	+2.19	0.07	0.09	+0.02
Tailings	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+6.05	0.45	0.54	+0.03
Pond	Subtotal					0	0	0		1.65	7.70	+6.05	0.39	0.46	+0.07
Water	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+0.25	0.45	0.54	+0.002
Pond	Subtotal					0	0	0		0.07	0.32	+0.25	0.02	0.022	+0.002
Refuse	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+6.05	0.45	0.54	+0.07
Dump	Subtotal					0	0	0		1.65	7.70	+6.05	0.39	0.46	+0.07
Sewage	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+0.66	0.45	0.54	+0.01
Pond	Subtotal					0	0	0		0.18	0.84	+0.66	0.04	0.05	+0.01
Training	II	C	90	67	0.9"	0	0.002	+0.04	1.9"	0.020	0.033	+0.26	0.85	1.10	+0.01
Mine	Subtotal					0	0.04	+0.04		0.04	0.66	+0.26	0.02	0.03	+0.01
Road to	C	B	77	44	0.9"	0	0	0	1.9"	0.007	0.007	+0.02	0.45	0.54	+0.001
Training	UU	D	81	76	0.9"	0.004	0.005	+0.01	1.9"	0.042	0.045	+0.01	1.20	1.30	+0.001
Mine	II	C	90	67	0.9"	0	0.002	+0.04	1.9"	0.020	0.033	+0.28	0.85	1.10	+0.02
	Subtotal					0.02	0.07	+0.05		0.68	0.99	+0.31	0.04	0.06	+0.02
Conveyor &	DD	B	33	11	0.9"	0.002	0.011	+0.11	1.9"	0.036	0.066	+0.36	0.50	0.64	------
Road to	C	B	77	44	0.9"	0	0	0	1.9"	0	0.007	+0.42	0.45	0.54	+0.01
Portals	Subtotal					0.02	0.13	+0.11		0.44	1.22	+0.78	0.05	0.06	+0.01
Water	II	C	90	67	0.9"	0	0.002	+0.01	1.9"	0.020	0.033	+0.08	0.85	0.98	+0.001
Pipeline	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+0.10	0.45	0.54	+0.001
	DD	B	33	11	0.9"	0.002	0.011	+0.02	1.9"	0.036	0.066	+0.08	0.50	0.64	------
	UU	D	81	76	0.9"	0.004	0.005	+0.01	1.9"	0.042	0.045	+0.01	1.20	1.30	+0.001
	Subtotal					0.02	0.06	+0.04		0.36	0.63	+0.27	0.02	0.023	+0.003
Conveyor	DD	B	33	11	0.9"	0.002	0.011	+0.14	1.9"	0.036	0.066	+0.45	0.50	0.64	+0.003
to Dump	UU	D	81	76	0.9"	0.004	0.005	+0.01	1.9"	0.042	0.045	+0.02	1.20	1.30	+0.002
	Subtotal					0.06	0.21	+0.15		0.87	1.34	+0.47	0.02	0.03	+0.01
Temp.	DD	B	33	11	0.9"	0.002	0.011	+0.68	1.9"	0.036	0.066	+2.25	0.50	0.64	+0.02
Coal Dump	Subtotal					0.15	0.83	+0.68		2.70	4.95	+2.25	0.06	0.08	+0.02
	TOTAL					0.61	3.23	+2.62		15.19	37.73	+22.54	1.20	1.47	+0.27

[a] P/S = Present situation
[b] A/D = After Disturbance

FIGURE 9

Changes in Runoff and Erosion Along Access Highways During Construction

			Percent Ground Cover		2 Yr., 6-hr. Duration Storm				50 Yr., 6-hr. Duration Storm				Est. Annual Sediment Yield (a/f/Mi.^{2})		
						Est. Runoff (a/f/ac.)				Est. Runoff (a/f/ac.)					
Facility	Soil Sym	Hydro Grp.	P/S[a]	A/C[b]	Rain-Fall	P/S[a]	A/D[b]	Change	Rain-Fall	P/S[a]	A/D[b]	Change	P/S[a]	A/D[b]	Change
Glen	W	A	53	9	0.9"	0	0	0	1.9"	0	.033	+0.20	0.35	0.40	-------
Canyon	0	D	70	59	0.9"	.008	.024	+0.97	1.9"	.032	.040	+0.48	0.65	0.72	+0.006
City to	WW	C	--	--	0.9"	.014	.018	+0.02	1.9"	.069	.078	+0.06	----	----	-------
Power	T	C	49	37	0.9"	.006	.009	+0.09	1.9"	.050	.062	+0.36	0.75	0.84	+0.005
Plant	LL	C	78	60	0.9"	.001	.003	+0.07	1.9"	.006	.015	+0.28	0.85	1.00	+0.008
	LL	C	78	60	0.9"	0.001	0.003	+0.04	1.9"	.006	.015	+0.16	0.85	1.00	+0.004
	T	C	24	9	0.9"	0.004	0.024	+0.12	1.9"	.077	0.100	+0.14	0.55	6.62	+0.001
	Subtotal					.98	2.74	+1.76		6.12	9.91	+3.79	0.26	0.31	+0.05
Power	II	C	90	67	0.9"	0	0.002	+0.02	1.9"	0.020	0.033	+0.16	0.85	0.98	+0.003
Plant	K	B	87	61	0.9"	0	0	0	1.9"	0.003	0.014	+0.17	0.45	0.54	+0.002
to	DD	B	33	11	0.9"	0.002	0.011	+0.38	1.9"	0.036	0.066	+1.29	0.50	0.64	+0.010
Cannonville	C	B	77	44	0.9"	0	0	0	1.9"	0	0.007	+0.55	0.45	0.56	+0.013
	DD	B	33	11	0.9"	0.002	0.011	+0.38	1.9"	0.036	0.066	+1.27	0.50	0.64	+0.010
	UU	D	81	76	0.9"	0.004	0.005	+0.04	1.9"	0.042	0.045	+0.13	1.20	1.30	+0.007
	C	B	57	22	0.9"	0	0.002	+0.01	1.9"	0	0.036	+0.11	0.45	0.56	-------
	E	C	65	42	0.9"	0	0.002	+0.08	1.9"	0.012	0.034	+0.87	0.50	0.70	+0.012
	I	B	58	28	0.9"	0	0.001	+0.01	1.9"	0	0.025	+0.15	0.45	0.62	+0.002
	Subtotal					0.32	1.07	+0.75		4.56	7.99	3.43	0.21	0.25	+0.04
GRAND TOTAL						1.30	3.81	+2.51		10.68	17.90	+7.22	0.47	0.56	+0.09

[a] P/S = Present Situation

[b] A/D = After Disturbance

FIGURE 10

Changes in Runoff and Erosion on East Clark Bench During Construction

			Percent Ground Cover		2 Yr., 6-Hr. Duration Storm				50 Yr., 6-Hr. Duration Storm				Est. Annual Sediment Yield (a/f/Mi.^{2})		
						Est. Runoff (a/f/ac.)				Est. Runoff (a/f/ac.)					
Facility	Soil Sym	Hydro Grp.	P/S[a]	A/C [b]	Rain-Fall	P/S[a]	A/D[b]	Change	Rain-Fall	P/S[a]	A/D[b]	Change	P/S[a]	A/D[b]	Change
New Town	0	C	70	59	0.9"	0.001	0.002	+0.64	1.9"	0.032	0.040	+ 5.12	0.65	0.78	+0.13
	W	A	53	9	0.9"	0	0.001	+2.24	1.9"	0	0.033	+73.92	0.35	0.60	+0.88
	0	C	88	71	0.9"	0	0.001	+1.60	1.9"	0.021	0.031	+16.00	0.65	0.70	+0.12
	TOTAL					0.64	5.12	4.48		54.08	149.12	+95.04	3.5	4.63	+1.13

[a] P/S = Present Situation
[b] A/D = After Disturbance

FIGURE 11

Changes in Runoff and Erosion on Aggregate Site and Access Road

Facility	Soil Sym	Hydro Grp.	Percent Ground Cover		2 Yr., 6-hr. Duration Storm				50 Yr., 6-hr. Duration Storm				Est. Annual Sediment Yield (a/f/Mi.^{2})		
			P/S[a]	A/C[b]	Rain-Fall	Est. Runoff (a/f/ac.) P/S[a]	A/D[b]	Change	Rain-Fall	Est. Runoff (a/f/ac.) P/S[a]	A/D[b]	Change	P/S[a]	A/D[b]	Change
Access Road	D	B	45	24	0.9"	0	0.002	+0.01	1.9"	0.007	0.033	+0.16	0.60	0.80	+0.002
	H	D	45	17	0.9"	0.001	0.003	+0.02	1.9"	0.033	0.068	+0.25	0.45	0.70	+0.003
	UU	D	87	73	0.9"	0.003	0.004	+0.01	1.9"	0.039	0.048	+0.03	1.25	1.45	+0.001
	TOTAL					0.01	0.05	+0.04		0.41	0.85	+0.44	0.016	0.022	+0.006

[a] P/S = Present Situation
[b] A/D = After Disturbance

cover remaining after disturbance is the rock of 1/4 to 2 inches in diameter that remains after the vegetation and litter have been removed. The changes in runoff as a result of disturbance for the two-year and 50-year storms are also shown. The change in runoff from the 50-year storm was obtained from Figures 2,3, 4, and 5. The change in sediment yield was obtained by subtracting the present estimated sediment yield from the projected sediment yield. The projected sediment yield considered only the changes in ground cover using procedures developed by the Pacific Southwest Interagency Committee.(Shown, 1970) The subtotals and total identify the acre-feet of runoff and sediment from each activity.

Figures 12, 13, 14, 15, 16 and 17 were then developed to identify the acre feet of runoff and sediment prior to, during and after construction of power plant, access roads and highways, water pipeline, coal mine and the proposed town.

The above figures consider only the effects of runoff and erosion and do not consider long-term effects during the life of the project. These will be discussed in the main text of Chapter III. However, access highways and roads are recognized as having a long-term influence on runoff, Because of this long-term effect, Figure 18 was developed to show the project runoff for two-year and 50-year storms of six hour duration on both paved and dirt roads for each of the four hydrologic soil groups. This figure applies only to the Kiaparowits Study Area.

The possibility of heavy metals and $CA\ SO_4$ rising through the one-foot soil mantle over the ash disposal area was also examined. Based on Brigham Young University and Bureau of Land Management Phase I Studies the soils range from a fine sandy loam to a loam in texture.

To determine potential capillary rise in the soils involved, the following formula was used: (Baver, 1959)

FIGURE 12

Acre-Feet of Runoff and Sediment Prior to, During and After Construction of Power Plant Complex. *

	Storm Runoff						Est. Annual Sediment		
	Prior		During		After				
	2 Yr.	50 Yr.	2 Yr.	50 Yr.	2 Yr.	50 Yr.	Prior	During	After
Power Plant & Support Fac.	0	1.7	0.42	8.3	4.8	10.0	0.21	0.29	0
Evaporation Ponds	0	0	0.18	4.5	0	0	0.13	0.17	0
Ash Disposal Site	0	5.8	0.94	16.3	0.50	11.1	0.38	0.53	0.45
Ash Haul Road	0	0.6	0.10	1.7	1.1	4.3	0.04	0.06	0.05
Water Storage Reservoir	0	0.8	0.18	3.2	0	0	0.08	0.11	0.03
Retention Pond	0	0	0	0.1	0	0	0	0	0
Total	0	8.9	1.84	34.1	6.4	25.4	0.84	1.16	0.53

* Acre-foot is the volume of water or sediment covering one acre the depth of one foot and is equal to 43,560 cubic feet.

FIGURE 13

Acre-Feet of Runoff and Sediment Prior to, During and After Construction of Pipeline

	Storm Runoff						Est. Annual Sediment		
	Prior		During		After				
	2 Yr.	50 Yr.	2 Yr.	50 Yr.	2 Yr.	50 Yr.	Prior	During	After
Pipeline	1.76	11.35	3.28	18.83	1.79	12.54	0.37	0.41	0.39
Pump Station (Lake Powell)	0	0.01	.01	0.02	0	.01	0	0	0
Pump Station (Nipple Bench)	0	0.13	0	0.30	0	0	0.01	0.01	0.01
Maintenance Road	0.55	4.46	0.95	5.29	1.34	6.21	0.07	0.08	0.08
Total	2.31	15.96	4.24	24.44	3.13	18.76	0.45	0.50	0.48

FIGURE 14

Acre-Feet of Runoff and Sediment Prior to, During and After Construction of Highways

	Storm Runoff						Est. Annual Sediment		
	Prior		During		After				
	2 Yr.	50 Yr.	2 Yr.	50 Yr.	2 Yr.	50 Yr.	Prior	During	After
Glen Canyon to Power Plant	0.98	6.12	2.74	9.91	4.89	21.02	0.26	0.31	0.29
Power Plant to Cannonville	0.32	4.56	1.07	7.99	3.17	13.87	0.21	0.25	0.23
Total	1.30	10.68	3.81	17.90	8.06	34.89	0.47	0.56	0.52

FIGURE 15

Acre-Feet of Runoff and Sediment Prior to, During and After Construction of Coal Mine Complex

	Storm Runoff						Est. Annual Sediment		
	Prior		During		After				
	2 Yr.	50 Yr.	2 Yr.	50 Yr.	2 Yr.	50 Yr.	Prior	During	After
Admin. Build.	0.10	1.80	0.55	3.30	3.70	7.90	0.04	0.05	0.04
Washery & Silo	0.10	1.80	0.55	3.30	3.70	7.90	0.04	0.05	0.04
Mine Portals	0.14	2.59	0.79	4.92	7.2	15.14	0.07	0.09	0.07
Tailings Pond	0	1.65	0	7.70	0	0	0.39	0.46	0
Water Pond	0	0.07	0	0.32	0	0	0.02	0.02	0
Refuse Pump	0	1.65	0	7.70	0	5.50	0.39	0.46	0
Sewage Pond	0	0.18	0	0.84	0	0	0.04	0.05	0
Training Mine	0	0.40	0.04	0.66	1.49	3.15	0.02	0.03	0
Road to Mine	0.02	0.68	0.07	0.99	0.22	1.08	0.04	0.06	0.05
Conveyor Road	0.02	0.44	0.13	1.22	0.22	1.41	0.05	0.06	0.06
Water Pipeline	0.02	0.36	0.06	0.63	0.02	0.36	0.02	0.023	0.02
Conveyor to Dump	0.06	0.87	0.21	1.34	0.10	0.52	0.02	0.03	0.03
Temp. Coal Dump	0.15	2.70	0.83	4.95	0	0	0.06	0.08	0
Total	0.61	15.19	3.23	37.73	16.65	42.96	1.20	1.47	0.31

FIGURE 16

Acre-Feet of Runoff and Sediment Prior to,
During and After Construction of New Town

	Storm Runoff						Est. Annual Sediment		
	Prior		During		After				
	2 Yd.	50 Yd.	2 Yd.	50 Yd.	2 Yd.	50 Yd.	Prior	During	After
New Town	0.64	54.08	5.12	149.12	40.61 (31.4 to 51.5)	223.25 (201.6 to 246.4)	3,50	4.63	4.10

FIGURE 17

Acre-Feet of Runoff and Sediment Prior to,
During and After Construction of Aggregate Access Road

	Storm Runoff						Est. Annual Sediment		
	Prior		During		After				
	2 Yd.	50 Yd.	2 Yd.	50 Yd.	2 Yd.	50 Yd.	Prior	During	After
Road	0.01	0.41	0.05	0.85	0.23	1.11	0.016	0.022	0.019

FIGURE 18

Water Runoff in Acre-Feet Per Acre for
Access Roads for Each Soil Hydrologic Group

	Acre Feet of Runoff Per Acres											
Type of Road	A*			B			C			D		
Including Right-of-way	Sxx c c N	xxx 2 yr*** *	50 yr***	s** c c N	2 yr***	50 yr***	s c c N	2 yr***	50 yr***	s c c N	2 yr***	50 yr***
Dirt	72		0.021	82	0.007	0.048	87	0.014	0.069	89	0.018	0.078
Paved	74	0.001	0.026	84	0.009	0.057	90	0.022	0.084	92	0.028	0.096

* Refers to Hydrologic Soil Group - see definition in soils section.

** Soil complex curve number as derived from Bureau of Land Management Erosion manual.

*** Storms are of 6-hour duration.

$$h = \frac{2T}{r\ d\ g}$$

h = Potential height in centimeters

T = Surface tension of water (75 dynes/centimeter)

r = radius of soil pores in centimeter

d = density of water (1 gram / cubic centimeters)

g = Gravitational acceleration (980 centimeters / second/second)

Capillary pore size is dependent on the particle size of soil particles. Figure 19, Particle Size Distribution, identifies the particle size that one can expect for fine sandy loam and loam textured soils.

Figure 19

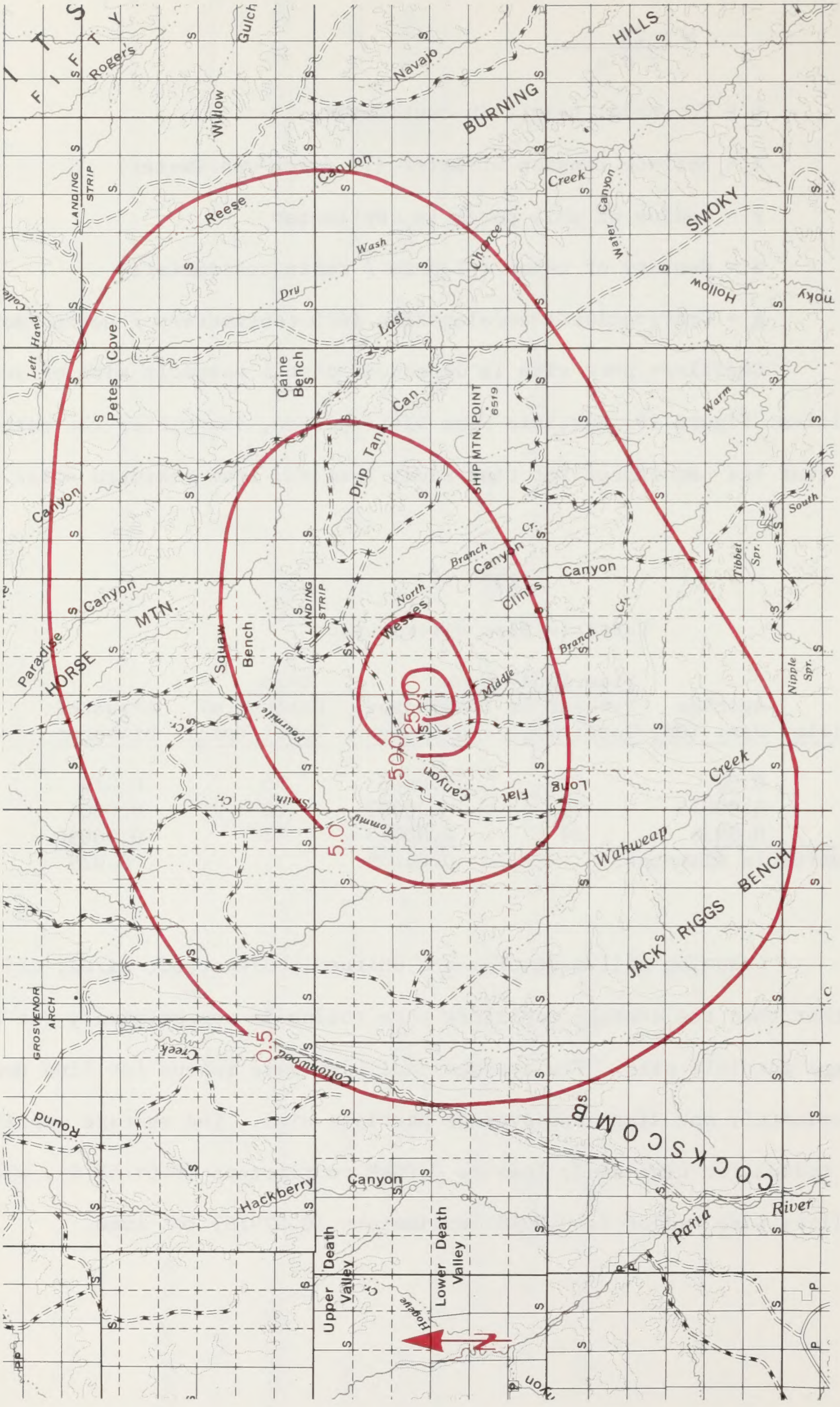
Particle Size Distribution

		Fine Sandy Loam		Loam	
Particle	Average Dia. (CM)	Percent of Total Vol.	Adjusted Diameter	Percent of Total Vol.	Adjusted Diameter
Sand	0.08	51	0.0408	35	0.028
Clay	0.00015	20	0.00003	28	0.0004
Silt	0.0026	29	0.00075	37	0.00096
New particle diameter			0.04158		0.029

Assuming soil particles are uniformly dispersed, sized, and placed together then the average capillary pore radius is approximately one sixth the average particle size. The average capillary pore radius for fine sandy loam approximately one sixth the average particle size. The average capillary pore radius for fine sandy loam is 0.0069 centimeters (0.04158/6), whereas the capillary pore radius is 0.0048 centimeters (0.029/6) for loam.

ILLUSTRATION i

ISOPLETHS OF SALT DEPOSITION



The potential capillary rise* for fine sandy loams is:

$$\frac{2(74 \text{ dynes / cm})}{(0.0069 \text{ cm})\ (1 \text{ gr/ cm}^3)\ (980 \text{ cm/sec}^2)} = \frac{150 \text{ cm}}{6.79} = 22.1 \text{ cm or } 8.7 \text{ inches}$$

The potential capillary rise for loam soils:

$$\frac{2\ (75 \text{ dynes/cm})}{(0.0048 \text{ cm})\ (1 \text{ gr/cm}^3)\ (980 \text{ cm/sec}^2)} = \frac{150 \text{ cm}}{4.704} = 31.9 \text{ cm or } 12.6 \text{ inches}$$

The two above examples represent the possible extremes that may be found on the site.

The problem of salt drift on soils was analyzed in the following manner:

Illustration 1 was used to determine the amounts of salt deposition and the area affected. (MRI, 1974)

From these data Figures 20 and 21 were developed to show the annual salt accumulation in the surface six inches of soil, assuming there is a five to ten percent loss due to surface runoff each year. These tables are for 250 and 50 pound rates of deposition per acre per year. However, before these annual rates of deposition can become meaningful, the following formula must be used to determine the concentration in parts per million:

$$\frac{\text{Lbs. of Salt per acre}}{2{,}000{,}000 \text{ Lbs. per acre}} = \text{Parts per Million (Richards, 1954),}$$

Parts per million is then converted to percent by dividing by $10,000. The percent salt is then divided by an electrical conductivity factor to determine the soil electrical conductivity in millimhos. Figure 22 was developed to determine the electrical conductivity factor. (Richards, 1954)

* Capillary rise: The rise of water in soil pores due to the interaction of surface tension of water and the forces of adhesion (attachment).

FIGURE 20

Salt Accumulation in Soils from Cooling Tower Drift At a Rate of 250 Lbs./Acre/Year

Year	Yearly Acc. Deposition	Yearly Runoff (5-10%)	Soil Salinity (P.P.M.)	Electrical Conduct. (Millimhos) (EC x 10^3)	
1	225-237	13-25	112-118	0.6 - 0.6	
2	427-463	24-48	213-231	1.1 - 1.2	Present Soil Ec x 10^3
3	609-677	36-68	305-338	1.5 - 1.7	
4	773-881	46-86	386-440	1.9 - 2.2	
5	921-1074	57-102	460-537	2.3 - 2.7	
6	1054-1258	66-117	427-629	2.6 - 3.1	
7	1174-1433	75-130	587-716	2.9 - 3.6	Nipple Bench 0.85 x 10^3
8	1282-1599	84-142	641-799	3.2 - 4.0	
9	1379-1757	92-153	689-878	3.4 - 4.4	
10	1466-1907	100-163	733-953	3.7 - 4.8	
11	1544-2049	108-172	772-1024	3.9 - 5.1	
12	1615-2184	115-179	808-1092	4.0 - 5.5	Fourmile Bench 1.1 x 10^3
13	1679-2312	122-186	839-1156	4.2 - 5.8	
14	1736-2434	128-196	868-1217	4.3 - 6.1	
15	1787-2550	134-199	893-1275	4.5 - 6.4	
16	1833-2660	140-204	916-1330	4.6 - 6.7	
17	1875-2764	146-208	937-1382	4.7 - 6.9	
18	1913-2863	151-212	956-1431	4.8 - 7.2	
19	1947-2957	156-216	973-1478	4.9 - 7.4	
20	1977-3046	161-220	988-1523	4.9 - 7.6	
21	2004-3131	165-223	1002-1565	5.0 - 7.8	
22	2029-3211	170-225	1014-1605	5.1 - 8.0	
23	2051-3288	173-228	1025-1644	5.1 - 8.2	
24	2071-3361	177-230	1035-1680	5.2 - 8.4	
25	2089-3430	181-232	1044-1715	5.2 - 8.6	
26	2105-3496	184-234	1052-1748	5.3 - 8.7	
27	2120-3559	187-235	1060-1779	5.3 - 8.9	
28	2133-3618	191-237	1066-1809	5.3 - 9.0	
29	2145-3674	194-238	1072-1837	5.4 - 9.2	
30	2156-3727	197-239	1078-1863	5.4 - 9.3	
31	2165-3778	199-241	1082-1889	5.4 - 9.4	
32	2173-3826	202-242	1086-1913	5.4 - 9.6	
33	2181-3872	204-242	1090-1936	5.5 - 9.7	
34	2188-3916	206-243	1094-1958	5.5 - 9.8	
35	2194-3958	208-244	1097-1979	5.5 - 9.9	
36	2200-3998	210-244	1100-1999	5.5 -10.0	
37	2205-4035	213-245	1102-2017	5.5 -10.1	
38	2209-4071	214-246	1104-2035	5.5 -10.2	
39	2213-4105	216-246	1106-2052	5.5 -10.3	
40	2217-4137	218-246	1108-2068	5.5 -10.3	
41	2220-4168	219-247	1110-2084	5.6 -10.4	
42	2223-4197	221-247	1111-2098	5.6 -10.5	
43	2226-4225	222-247	1113-2112	5.6 -10.6	
44	2228-4251	224-248	1114-2125	5.6 -10.6	
45	2230-4276	225-248	1115-2138	5.6 -10.7	
46	2232-4300	226-248	1116-2150	5.6 -10.8	
47	2234-4323	227-248	1117-2161	5.6 -10.9	
48	2236-4364	230-249	1118-2182	5.6 -10.9	
49	2237-4364	230-249	1118-2182	5.6 -10.9	
50	2238-4383	231-249	1119-2191	5.6 -11.0	
Total	8,117-10,265				

FIGURE 21

Salt Accumulation in Soils from Cooling Tower Drift
At a Rate of 50 Lbs./Acre/Year

Year	Yearly Acc. Deposition	Yearly Runoff (5-10%)	Soil Salinity (P.P.M.)	Electrical Conduct. (Millimhos) ($EC \times 10^3$)	
1	45- 48	2-5	22- 24	0.11 - 0.12	
2	86- 88	5-9	43- 44	0.22 - 0.22	
3	124-131	7-12	62- 65	0.31 - 0.32	Present Soil
4	157-172	9-17	78- 86	0.39 - 0.43	$Ec \times 10^3$
5	186-220	12-21	93-110	0.47 - 0.55	
6	212-257	13-24	106-128	0.53 - 0.64	
7	236-292	15-26	118-146	0.59 - 0.73	Nipple Bench
8	257-325	17-29	128-162	0.64 - 0.81	
9	276-356	19-31	138-178	0.69 - 0.89	0.85×10^3
10	293-386	20-33	146-193	0.73 - 0.97	
11	309-414	22-34	154-207	0.77 - 1.03	
12	323-441	23-36	161-220	0.80 - 1.10	Fourmile Bench
13	336-466	25-37	168-233	0.84 - 1.17	
14	347-490	26-39	173-245	0.87 - 1.23	1.1×10^3
15	357-513	27-40	178-256	0.89 - 1.28	
16	366-535	28-41	183-267	0.92 - 1.34	
17	374-556	29-42	187-278	0.94 - 1.39	
18	382-575	30-42	191-287	0.96 - 1.44	
19	389-594	31-43	194-297	0.97 - 1.49	
20	395-612	32-44	197-306	0.99 - 1.53	
21	400-629	33-45	200-314	1.00 - 1.57	
22	405-645	34-45	202-322	1.01 - 1.61	
23	410-660	35-45	205-330	1.02 - 1.65	
24	419-675	35-46	209-337	1.04 - 1.69	
25	422-689	36-47	211-344	1.05 - 1.72	
26	425-702	37-47	212-351	1.06 - 1.76	
27	428-714	38-47	214-357	1.07 - 1.79	
28	430-726	38-48	215-363	1.08 - 1.82	
29	432-737	39-48	216-368	1.08 - 1.84	
30	434-748	39-48	217-374	1.09 - 1.87	
31	436-758	40-48	218-379	1.09 - 1.90	
32	437-768	40-49	218-384	1.09 - 1.92	
33	438-777	41-49	219-388	1.10 - 1.94	
34	439-786	41-49	219-393	1.10 - 1.97	
35	440-796	42-49	220-398	1.10 - 1.99	
36	441-804	42-49	220-402	1.10 - 2.01	
37	442-811	43-49	221-405	1.11 - 2.03	
38	443-818	43-49	221-409	1.11 - 2.05	
39	444-825	43-49	222-412	1.11 - 2.06	
40	445-831	44-49	222-415	1.11 - 2.08	
41	446-836	44-49	223-418	1.12 - 2.09	
42	446-842	44-50	223-421	1.12 - 2.11	
43	446-847	45-50	223-423	1.12 - 2.12	
44	446-852	45-50	223-426	1.12 - 2.13	
45	446-857	45-50	223-428	1.12 - 2.14	
46	446-862	45-50	223-431	1.12 - 2.16	
47	446-866	46-50	223-433	1.12 - 2.17	
48	446-870	46-50	223-435	1.12 - 2.18	
49	446-874	46-50	223-437	1.12 - 2.19	
50	446-878	46-50	223-439	1.12 - 2.20	
Total		1629 - 2059			

FIGURE 22

Electrical Conductivity Factor for Various Soil Textures

Textural Class	Range of Saturation (%)	Elec. Fact. Range	Average Elect. Fact
Coarse	12.5 to 25	0.008-0.016	0.012
Mod.-Coarse	25 to 37.5	0.016-0.024	0.020
Medium	37.5 to 50	0.024-0.032	0.028
Mod.-Fine	50 to 75	0.032-0.048	0.040
Fine	75 to 100	0.048-0.064	0.056

Because the soils involved are sandy loam a factor of 0.020 was used.

Figure 23 was developed to show the time sequence of salt deposition and its effects on vegetation. The assumptions on the salt effects on vegetation are also in the table. Salt concentration, as expressed in millimhos, is an indicator of salinity hazard.

The alkalinity hazard is determined by the Sodium Absorption Ratio. (SAR). The SAR is determined by the following formula:

$$\frac{Na}{\frac{Ca + Mg}{2}} = SAR$$

The concentrations of sodium, calcium and magnesium are expressed in milliequivalents.

FIGURE 23

Time Sequence of Salt Deposition (in Millimhos) on Soils and Vegetation for Fourmile Bench

Ave. Radius from Cooling Towers (Miles)	Ave. Salt Deposition (lb./Ac./Yr.)	Area in Acres	Accum. Area in Acres	Years for Soil[a] to Attain Selected Elec. Cond. Levels[b]			Soil Elec. Conductivity Levels at the end of 35 and 50 Year Periods	
				4×10^3	6×10^3	12×10^3	Lapse of 35 Yrs.	Lapse of 50 Yrs.
0.00-0.40	250.0	320	320	6	10	49	11.00×10^3	12.06×10^3
0.40-0.52	187.5	220	540	8	16	--	8.53×10^3	9.32×10^3
0.52-0.55	115.0	70	610	15	44	--	5.66×10^3	6.14×10^3
0.55-0.64	95.0	215	825	20	--	--	4.86×10^3	5.27×10^3
0.64-0.78	75.0	400	1255	28	--	--	4.07×10^3	4.39×10^3
0.78-0.96	55.0	635	1860	--	--	--	3.28×10^3	3.51×10^3 c
0.96-1.18	35.0	940	2800	--	--	--	2.49×10^3	2.63×10^3
1.18-1.23	23.75	240	3040	--	--	--	2.04×10^3	2.14×10^3
1.23-1.32	21.63	460	3500	--	--	--	1.96×10^3	2.05×10^3
1.32-1.46	19.38	790	4290	--	--	--	1.87×10^3	1.95×10^3
1.46-1.65	17.13	1180	5470	--	--	--	1.78×10^3	1.85×10^3
1.65-1.89	14.88	1710	7180	--	--	--	1.69×10^3	1.75×10^3
1.89-2.17	12.63	2285	9465	--	--	--	1.60×10^3	1.65×10^3
2.17-2.50	10.38	3100	12565	--	--	--	1.51×10^3	1.55×10^3
2.50-2.88	8.13	4115	16680	--	--	--	1.42×10^3	1.46×10^3
2.88-3.31	5.88	5350	22030	--	--	--	1.33×10^3	1.36×10^3
3.31-3.78	3.63	6700	28730	--	--	--	1.24×10^3	1.26×10^3

[a] The present electrical conductivity of the Fourmile Bench soils is 1.1×10^3 (millimos)

[b] The soil electrical level as expressed in millimhos is an indicator of salinity hazard.

[c] The following assumptions were made for the salinity tolerance of various types of vegetation (Gates, Stoddard & Cook, 1956) (Richard, 1954) (Bernstein, 1958)

4×10^3 - The upper limit of sagebrush and pinyon-juniper vegetation

6×10^3 - The upper limit of most grasses and forbs.

12×10^3 - The upper limit of all grasses and forbs.

16×10^3 - The upper limit of salt tolerant shrubs.

APPENDIX III-7

Acres of Vegetation by Major Type Lost to Structural Features

APPENDIX III-7

FIGURE 1

Wildlife

Kaiparowits Plateau impact area

Acres of vegetation by major type lost to structural features

Project Feature	VEGETAL TYPE Barren		Pinyon-Juniper Woodland		Mixed Shrub-Grass-Scattered Juniper		Salt Desert Shrub-Desert Grass		Riparian Bottomland		Scattered Ponderosa-&Bristlecone Pine		Totals	
	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temp.	Permanent	Temporary	Perm.	Temp.
Plant Site	-	-	930	1,170	-	-	-	-	-	-			930	1,170
Water Pipeline	100	275	25	70			100	275	-	-			225	620
Mine	-	-	-	-	1,710	1,910	-	-	-	-			1,710	1,910
Aggregate Sites and access road	85	90					330	330					415	420
New Town	-	-	-	-	200	300	2,040	4,180	-	-			2,240	4,480
Highway	28	40	82	118	55	79	83	119	27	39			275	395
Limestone Quarry	-	-	156	156	36	36					48	48	240	240
Total	208	400	1,193	1,514	2,001	2,325	2,553	4,904	27	39	48	48	6,035	9,235
Permanent	6,035													
Temporary	9,235													

APPENDIX III-8

Museum of Northern Arizona Report

APPENDIX III - 8

MUSEUM OF NORTHERN ARIZONA

DEPARTMENT OF GEOLOGY

Southern California Edison Company

Kaiparowits Power Project

Private, State of Arizona, State of Utah and

Bureau of Land Management Lands, Kanab District,

Washington and Kane Counties, Utah

Coconino County, Arizona

Phase I Report

for

Paleontological Investigations

Phase I - Kaiparowits Power Project; Report of

Paleontological Resources on Plant Sites, Related Facilities,

Associated Access Roads, Impact Area, and

Proposed Transmission Lines

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August 12, 1974

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XIII. List of Fossil Localities Discovered During Phase I Survey on Fourmile Bench and Nipple Bench Sites and a Description of Fauna and Flora

Introduction

This report presents the results of an overview study of paleontological resources on areas to be impacted by the proposed Kaiparowits Power Plant Sites (Fourmile Bench Site and Nipple Bench Site) and associated Transmission Lines Sites (Kaiparowits Power Plant to Eldorado; and Kaiparowits Power Plant via Moenkopi Substation to Mohave). This study was supported by a grant from Southern California Edison Company (SCE) (purchase orders U1754001 dated 6/20/74 and U4895151 dated 7/3/74).

The study was done in two parts. The first involved a literature survey to determine 1) what geological formations are exposed in the areas covered by this project, 2) what specific paleontological studies and findings have been made with regard to these formations, both within and outside of the project areas, and 3) what paleontological resources might be expected to occur within the project areas in exposures of these formations which have not yet been subjected to paleontological examination. This part of the study was undertaken from July 22 to July 26, 1974. A summary of the literature findings was presented in a report to Mr. Michael Gardner, dated July 31, 1974. For the sake of completion this data is again discussed in the present report.

The second part of the study involved a field spot checking of the project areas with emphasis on 1) locations of plant sites, mines, and related facilities where extensive alteration of the surface and underlying rock can be expected to occur during construction and operation of the power facilities, 2) transmission line corridors, and 3) previously unstudied or poorly studied exposures of formations known to contain significant paleontological material. The second part of this study was undertaken from August 5 to August 8, 1974. August 5th and 6th were spent at the Fourmile Bench Plant Site, August 7th was spent flying the Kaiparowits Power Plant to Eldorado Transmission Line Corridor by helicopter, and August 8th was spent on the Nipple Bench Site and mine sites. Data on the Kaiparowits Power Plant via Moenkopi Substation to Mohave Transmission Line Corridor is based strictly on the literature survey.

The survey was conducted by the following personnel of the Department of Geology, Museum of Northern Arizona: Mr. William J. Breed (Administrator); Mr. Larry G. Marshall (Senior Paleontologist); Mr. Tim Rowe (Supervisory Paleontologist); and Miss Gail Armstrong (Laboratory Technician). Helicopter transportation was supplied by SCE for August 7 and 8 and the pilot was Mr. John Scheidemantle.

Plant Sites

Within the area of the proposed plant sites (Fourmile Bench Site and Nipple Bench Site) occur exposures of nine geological formations. These are, from youngest (top) to oldest (bottom):

Kaiparowits Formation	Cretaceous
Wahweap Sandstone	
Straight Cliffs Sandstone	
Tropic Shale	
Dakota Sandstone	
Morrison Formation	Jurassic
Entrada Sandstone	
Carmel Formation	
Navajo Sandstone	Triassic-Jurassic boundary

All are of Mesozoic Age (latest Triassic to late Cretaceous) or approximately 180 to 65 million years old.

Fossil faunas and floras recorded from these formations along with literature references are presented in Appendices I-IX respectively. Fossils from these formations known to occur in the Kaiparowits Plateau Region are marked by an asterisk(*).

Fourmile Bench Site (Fig. 1): Two geologic formations are exposed on the Fourmile Bench Site. The Kaiparowits Formation is exposed on the northern half and the Wahweap Sandstone is exposed on the southern half.

Eight fossil sites were found on the Fourmile Bench Site (see Fig. 1, and Appendix XIII). Six of these occur in the Kaiparowits Formation and two in the underlying Wahweap Sandstone.

Site K-1 is the most important locality on the lease area. Dinosaur bones, fragments of turtle shells, reptile teeth, fish scales, and three species of gastropods were recorded from this site. A similar fauna was found at site K-3 although the material there is not as abundant as at site K-1. Both of these sites are deemed to be of major significance. It is recommended that these areas be surveyed in more detail and that large collections be made of the fossil material.

Small fragments of fossil bone and fish scales were found in a coarse sandstone or gravel at sites K-4, K-5, and K-6. Exposures of this gravel occur over a large part of the lease area and represent the lower part of the Kaiparowits Formation. These gravels should be investigated in more detail as there is a good chance that fossil mammals will be found in them.

The two fossil wood sites (one in the Kaiparowits Formation and the other in the Wahweap Sandstone) are of little importance. A large palm(?) leaf was found at site K-2 in the Wahweap Sandstone and it may be desirable to obtain this specimen for display purposes, possibly in the Fourmile Bench Plant Office.

In summary, fossil vertebrates were found to be relatively abundant in the Kaiparowits Formation on the Fourmile Bench Site and additional survey and collection of material is recommended. The Wahweap Sandstone was found to be sparsely fossiliferous, although additional survey may reveal more fossil sites.

Nipple Bench Site (Fig. 2): Two geologic formations are exposed on the Nipple Bench Site. The Wahweap Sandstone covers all of the upper plateau surface, while Straight Cliffs Sandstone is exposed of canyon bottoms within the southern impact area.

Fossil vertebrates and plants were found at three sites (K-7, K-8, K-9) on the lease area and all occur in the Wahweap Sandstone (see Fig. 2, and Appendix XIII). Sites K-7 and K-8 are deemed to be of major importance and additional survey and collection is recommended at these sites. Fragments of turtle shells and dinosaurs were abundant at both localities. There is also an excellent chance that fossil mammals will eventually be discovered at these sites. Several crocodile teeth were also observed at site K-7.

Only a few bone and wood fragments were found at site K-9, although this area was surveyed for only a few minutes and additional survey will probably reveal more material.

It is important to note that only three areas on the Nipple Bench Site were surveyed and all were found to contain fossil remains. It is thus very probable that additional survey of this site will reveal many more fossil localities.

In summary, it is highly recommended that additional paleontological survey be undertaken on the Nipple Bench Site and that samples of the fossil material be collected for study and preservation.

Associated Facilities and Access Roads: Because of time limitations it was not possible to survey the pump station sites or associated access roads for the plant sites. The northern pump station will be located on Straight Cliffs Sandstone and the southern pump station on Entrada Sandstone. It would appear from the literature survey that impact on these formations would be low, although it would be desirable to survey these areas before construction begins.

The following formations will be crossed by the water supply pipeline from the southern pumping station to the northern pumping station: Entrada Sandstone, Morrison Formation, Dakota Sandstone, Tropic Shale, and Straight Cliffs Sandstone (respectively). Impact on these areas is deemed to be low based on the literature survey. It would be desirable to confirm this assumption with a field survey.

Mines

Of the three mine sites designated, only the westernmost one (#3) could be located. A plant impression was found in the coal bed at this site and it would be desirable to have a paleobotanist spend some time there and make additional collections of this material. The two eastern mine sites (both #1's) should also be surveyed by a paleobotanist before initiation of mining activities.

Transmission Lines

Kaiparowits Power Plant to Eldorado 500KV Line: The proposed route for this transmission line was surveyed by helicopter on August 6, 1974. The formations which will be crossed by the line are listed in Appendix XI and the environment of deposition, age and fossils present are given along with an estimate of the impact that the line will have on each formation.

From the Fourmile Power Plant the line will extend south-southwest, parallel the Cockscomb Monocline and pass, for the most part, through Cottonwood Canyon. The impact to the formations which it will lie on (Kaiparowits thru Moenkopi) is considered low in all but two cases (Kaiparowits and Wahweap it is considered medium-high).

From the southern edge of the Cockscomb Monocline to Nevada the transmission line will lie for the most part on the Moenkopi Formation and to a less extent on the upper surface of the Kaibab Formation. The impact on the former is considered as medium and on the latter as low. At the Hurricane Fault the line crosses small exposures of Kaibab-Toroweap-Coconino-Supai and Redwall, but only for a short (1/2 mile) distance. These formations are exposed on the eastern (up thrust) side of the fault while the western (down thrust) side is made up of Moenkopi sediments. Between St. George and the Hurricane Hills there are some Pliocene (?) basalts overlying the Moenkopi Formation. West of St. George and the Virgin River the line again crosses small exposures of Moenkopi-Kaibab-Toroweap-Coconino-Supai and Redwall, but none of these appear to be of major paleontological significance.

Of the formations crossed by this transmission line in Utah and Arizona only the Moenkopi Formation will be noticeably affected by impact. A list of the fossil fauna recorded from the Moenkopi Formation is given in Appendix X. Although several exposures of Moenkopi occur between the Hurricane Hills and the Cockscomb Monocline none of the exposures examined which will be crossed by the lines contain paleontological resources deemed to be of major significance. Extensive exposures of the Moenkopi Formation occur just west of the Hurricane Fault and these may warrant further investigation. We had an opportunity to survey these exposures for about 45 minutes and did find a small bed of pelecypods (clams). These are not considered of major significance, although we hasten to add that the exposures are extensive in this area and we sampled only a small portion of them.

In summary, it is deemed that there will be very low impact on the geological formations and paleontological resources crossed by the Kaiparowits to Eldorado Transmission Line.

Kaiparowits Power Plant via Moenkopi Substation to Mohave: The geologic formations which will be crossed by this transmission line are listed in Appendix XII and the environment of deposition, age and fossils present are given along with an estimate of the impaction that the line will have on each formation.

This route was not surveyed by paleontologists and the estimate of impaction on each formation is based solely on the literature survey. These impaction estimates can only be regarded as tentative at this time and it would be desirable to field-survey this route by helicopter before initiation of construction activities.

Outline of Recommended Additional Work

The Phase I field-survey has revealed the presence of an abundance of paleontological resources on the proposed Fourmile Bench and Nipple Bench Plant Sites. Fossil plants were also found to occur at the #3 mine site and fossil shells were found in Moenkopi exposures which will be crossed by the Kaiparowits to Eldorado transmission line.

Both #1 mine sites and the Kaiparowits to Mohave transmission line corridor were not checked by field-survey. The literature survey has shown that fossils are recorded from all formations which occur on the proposed plant sites, associated facilities sites, sites for access roads, mine sites, and areas to be crossed by the transmission lines.

Because of the short time (4 days) spent in the field it is difficult to adequately assess the true significance of the paleontological resources which were encountered. To do this will require additional field-survey with emphasis on locating fossil sites and determining the abundance and diversity of the faunas and floras (Phase II Survey). After this is done it will be possible to outline recommendations for a full scale salvage program (Phase III Salvage).

Phase II Survey: It is recommended that the following additional field-survey be undertaken before initiation of a salvage program:

I. That four paleontologists spend five days (twenty man days) at each of the following sites:

1) Fourmile Bench Site
2) Nipple Bench Site
3) Moenkopi exposures in Hurricane Hills just east of St. George, Utah

II. That two paleontologists (including one paleobotanist) spend two days each (four man days) at each of the three mine sites.

III. That the Kaiparowits Power Plant via Moenkopi Substation to Mohave Transmission Line corridor be surveyed by helicopter by two paleontologists.

The Phase II Survey is organized for the purpose of making a precise assessment of the paleontological resources on an area. Emphasis is placed on locating fossil sites, determining the abundance and diversity of the faunas and/or floras, and making sample collections of these materials to aid in determining the significance of these resources.

A proposal and cost estimate for a Phase II Survey can be supplied by the Department of Geology, Museum of Northern Arizona at the request of SCE officials.

Phase III Salvage: Depending upon the findings of Phase II Survey it may be necessary to organize a program to collect large samples of fossils from different localities for the purpose of study, preservation and eventual publication. If paleontological resources are deemed to be abundant on an area it will be desirable to obtain good samples of these faunas before they are destroyed by construction activities or disturbed by impaction.

A Phase III Salvage proposal and cost estimate can be drafted only after completion of a Phase II Survey program.

Bibliography

Baker, A. A.; C. H. Dane; and J. B. Reeside. 1936. Correlation of the Jurassic Formations of Parts of Utah, Arizona, New Mexico, and Colorado: U.S.G.S. Prof. Pap. 183.

Brady, L. F. 1935. Preliminary note on the occurrence of a Primitive Therepod in the Navajo: Am. Jour. Sci., 30(5):210-215.

____________ 1936. A note concerning the fragmentary remains of a small therepod received from the Navajo Sandstone in northern Arizona: Am. Jour. Sci., 31(5):150.

Breed, W. J. 1968. The Age of Dinosaurs in Northern Arizona: Museum of Northern Arizona, Flagstaff, Arizona, 45 pp.

Camp, C. C. 1936. A new type of small bipedal dinosaur from the Navajo Sandstone of Arizona: Univ. Calif. Publ. Geol. Sci., 24(2):39-56.

Galton, P. 1971. The prosauropod dinosaur Ammosaurus, the crocodile Protosuchus, and their bearing on the age of the Navajo Sandstone of northeastern Arizona: Jour. Paleo., 45(5):781-795.

Gilluly, J.; and J. B. Reeside. 1927. Sedimentary Rocks of the San Rafael Swell and some adjacent areas in eastern Utah: U.S.G.S. Prof. Pap. 150:61-110.

Gregory, H. E.; and R. C. Moore. 1931. Kaiparowits Region: U.S.G.S. Prof. Pap. 164.

Gregory, H. E. 1950. Zion Park Region: U.S.G.S. Prof. Pap. 220.

Lawrence, J. C. 1965. Stratigraphy of the Dakota and Tropic Formations of Cretaceous age in southern Utah: In: Guidebook to the Geology of Utah, No. 19. Ed. H. D. Goode and R. A. Robison, pp. 71-92.

Lee, W. T. 1923. Continuity of some oil-bearing sands of Colorado and Wyoming: U.S.G.S. Bull. 751-A, pp. 1-22.

McKee, E. D. 1954. Stratigraphy and History of Moenkopi Formation: Geol. Soc. of Am. Memoir 61, 133 pp.

Mook, C. C. 1916. A study of the Morrison Formation: Ann. N.Y. Acad. Sci., 27:39-191.

Peterson, F.; and H. A. Waldrop. 1965. Jurassic and Cretaceous Stratigraphy of South - Central Kaiparowits Plateau, Utah: In: Guidebook to the Geology of Utah, No. 19. Ed. H. D. Goode and R. A. Robison, pp. 47-69.

Poborski, Stanislaw J. 1954. Virgin Formation (Triassic) of the St. George, Utah, area: Geol. Soc. of Am. Bull., 65(10):971-1006.

Stokes, W. L. 1944. Morrison and Related Deposits in and Adjacent to the Colorado Plateau: Geol. Soc. Am. Bull. 55:951-992.

Waage', K. M. 1959. U.S.G.S. Bull. 1081-B:13-26.

Fig. 1 Map of Fourmile Bench Site.

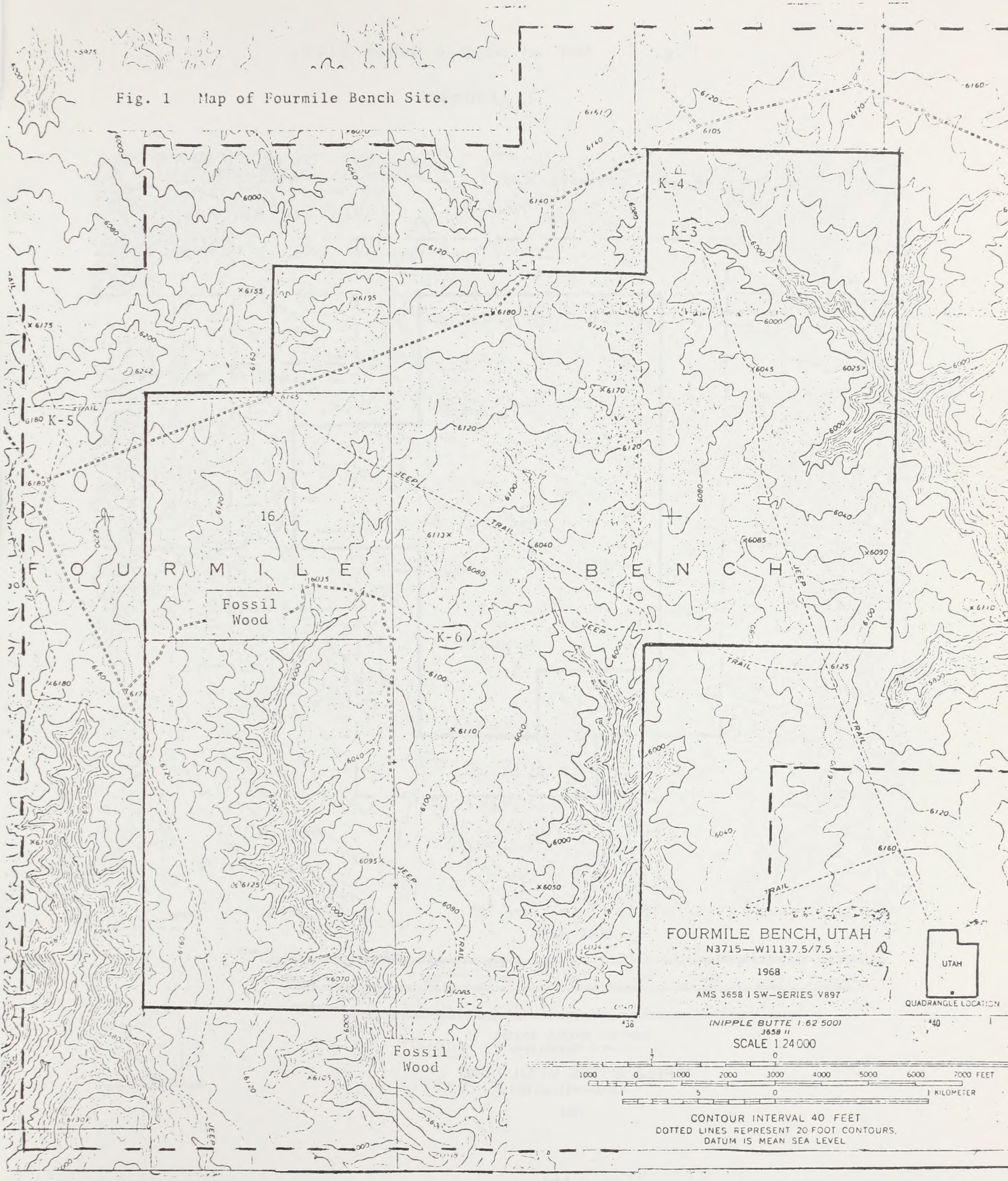
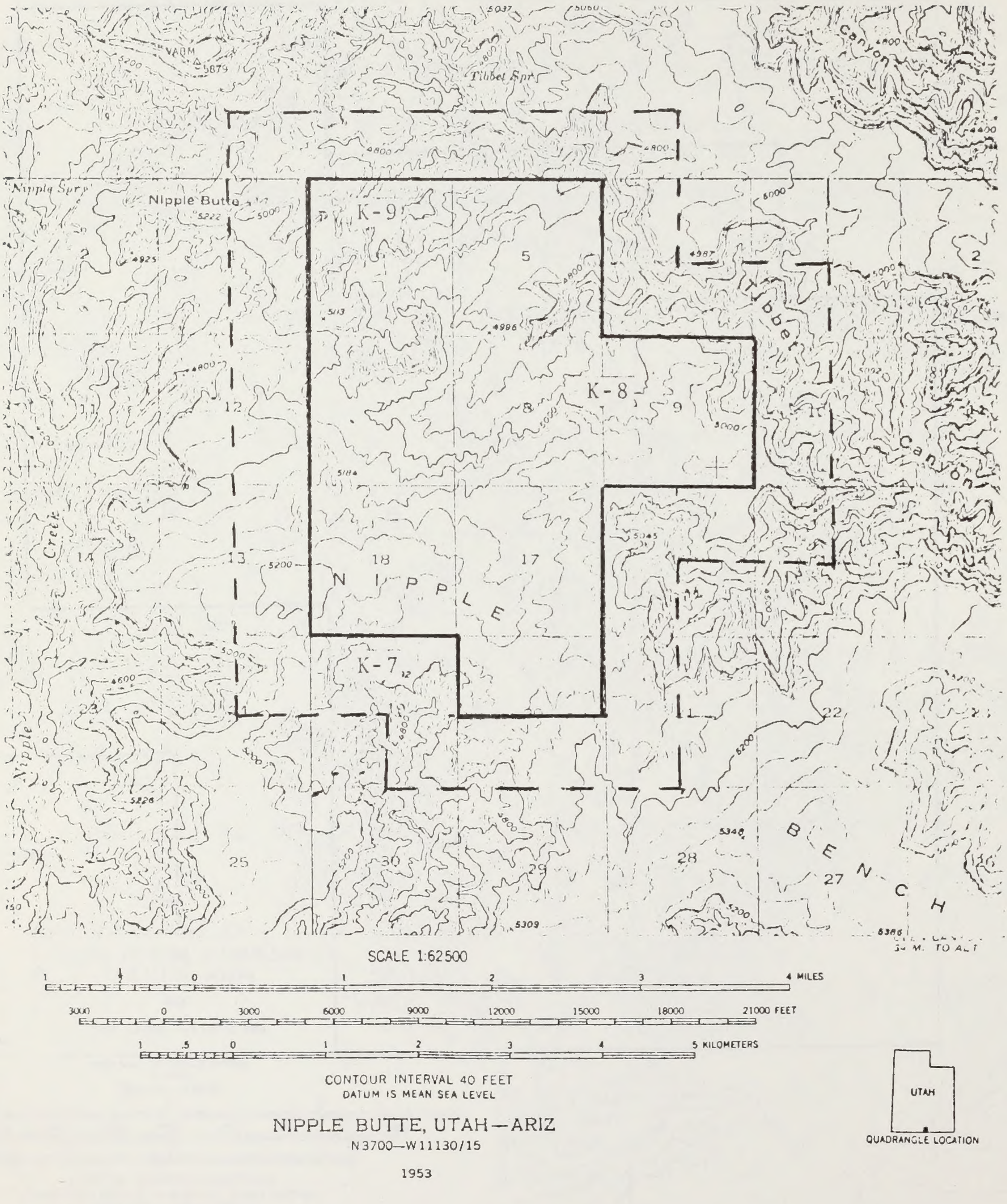


Fig. 2 Map of Nipple Bench Site.



Appendix I

Fossil fauna recorded from Kaiparowits Formation. Data from Gregory (1931, 1950). Taxa known to occur in Kaiparowits Plateau Region (*).

Invertebrates

*Campeloma sp.
*Goniobasis sp.
*Physa sp.
Planorbis?
*Unio (5 species)
*Viviparus (3 species)

Vertebrates

Dinosaurs
    *Triceratops sp.
    *Anatosaurus sp.
    Nodosauridae
    Therepoda
Crocodilia
Chelonia
    Basilimys sp.
    Adocus sp.
    *Baena sp.
    Trionychid

Appendix II

Fossil fauna and flora recorded from Wahweap Sandstone. Data from Gregory (1950, pp. 107-108).

Fossils scarce - "Those from unquestioned Wahweap strata include species of dinosaur (?) and turtle (?) bones, many well preserved impressions of leaves, and (invertebrates) *Neritina*, *Viviparus*, and *Physa*..." (Gregory 1950, pp. 107-108).

Appendix III

Fossil fauna recorded from Straight Cliffs Sandstone. Data from Gregory (1950, p. 107). Taxa known to occur in Kaiparowits Plateau Region (*).

Invertebrates

- *Admetopsis* sp.
- *Anomia* sp.
- **Barbatia* sp.
- *Campeloma* sp.
- **Cardium* sp.
- *Cerithium* sp.
- **Chemnitzia* sp.
- *Corbula* sp.
- *Cyrena* sp.
- *Fusus* sp.
- *Glauconia* sp.
- **Gyrodes* sp.
- **Inoceramus* sp.
- **Mactra* sp.
- **Membranipora* sp.
- *Neritina* sp.
- *Nucula* sp.
- *Ostrea* (2 species)
- *Physa* sp.
- **Plicatula* sp.
- *Planorbis* sp.
- **Turitella* sp.
- *Turbonilla* sp.
- **Volsello* sp.
- *Viviparus* (2 species)

Vertebrates

"Bones of Vertebrates"

Appendix IV

Fossil fauna recorded from Tropic Formation. Data from Gregory (1931, 1950). Taxa known to occur in Kaiparowits Plateau Region (*).

Invertebrates

*_Acanthoceras_ sp.
Admetopsis sp.
Anatina sp.
*_Anchura_ (2 species)
*_Anomia_ sp.
Baculites sp.
Barbatia sp.
Buchiceras sp.
*_Camptonectes_ sp.
Cardium sp.
*_Corbula_ (3 species)
Cyrena (2 species)
Eulimella sp(?)
Exiteloceras sp.
*_Exogyra_ (2 species)
Fusus sp.
Gloconia sp.
*_Gryphea_ (2 species)
Helioceras sp.
*_Inoceramus_ (3 species)
Legumen sp.
*_Lima_ sp.
Lidpistha (2 species)
Lucina (2 species)
*_Lunatia_ (2 species)
Mactra (2 species)
Metoicoceras sp.
*_Modiola_ sp.
Nemodon sp.
*_Ostrea_ (3 species)
Placenticeras sp.
Plicatula sp.
*_Serpula_ sp.
Sigaretus sp.
Tellina sp.
Tritonium sp.
*_Turritella_ (2 species)
*_Veniella_ sp.
Volsella (2 species)

Appendix V

Fossil fauna and flora recorded from Dakota Sandstone. Data from Lexicon of Geologic Names (1960, p. 1035); and Waage' (1959, pp. 13-26).

"Fossils not common in lower part, but plant remains include coniferous wood, cycadeoids, charophytes and other algae and foliage of ferns and cycods; animal remains include dinosaur bones, fresh-water molluscs, ostracods, and brachiopods".

"Fossils in marginal marine beds include dicotyledonous leaves, wood, false trunks of Tempskya, some fresh-water clams, linguloid, brachiopods, and foraminifera. Marine beds contain pelecypods, gastropods, Linguloid brachiopods, foraminifera, bones of fish, crocodiles and plesiosaurs".

Appendix VI

Fossil fauna and flora recorded from Morrison Formation. Data from Mook (1916, pp. 126-149). (Note: Much work on the fauna has been done since this faunal and floral list was compiled. A major library effort will be need to compile a more updated list). (Also see Breed 1968).

Flora

- *Cycadella* (11 species)
- *Araucarioxylon* sp.(?)
- *Pindxylon* sp.(?)

Invertebrates ("Invertebrate fauna is exclusively fresh-water in character")

- Pelecypoda
  - *Unio* (10 species)
- Gastropoda
  - *Limnoea* (3 species)
  - *Planorbis* sp.
  - *Vorticifex* sp.
  - *Valuata* sp.
  - *Viviparus* sp.
  - *Lioplacodes* sp.
  - *Neritina* sp.
  - *Valvata* sp.
- Ostracoda
  - *Metacypris* (2 species)
  - *Darwinula* sp.
  - *Cypris* (3 species)
- Arundel Forms
  - *Bythinia* sp.
  - *Viviparus* (2 species)
  - *Cyrena* sp.

Vertebrates

Mammalia

Allodon (2 species)
Asthedon sp.
Dryolestes (5 species)
Ctenacodon (3 species)
Dicrocynodon sp.
Docodon
Ennacodon (2 species
Paurodon sp.
Stylacodon (2 species
Laodon sp.
Priacodon sp.
Menacodon sp.
Tinodon (3 species)
Triconodon sp.

Aves

Laopteryx sp.

Reptilia

Sauropoda

Astrodon sp.
Dystrophaeus sp.
Atlantosaurus (2 species)
Camarasaurus (2 species)
Caulodon (2 species)
Apatasaurus (2 species)
Morosaurus (5 species)
Amphicoelias (3 species)
Symphyrophus sp.
Epantherias sp.
Diplodocus (3 species)

Apatosaurus sp.

Brontosaurus (2 species)

Pleurocoelus (3 species)

Barosaurus (2 species)

Elosaurus sp.

Haplocanthosaurus (2 species)

Brachiosaurus sp.

Theropoda

Dryptosaurus sp.

Hypsirophus sp.

Allosaurus (2 species)

Creosaurus (2 species)

Antrodesmus (2 species)

Coelurus (3 species)

Tichosteus (2 species)

Ceratosaurus sp.

Ornitholestes sp.

Predentata

Stegosaurus (9 species)

Diracodon sp.

Hoplitosaurus sp.

Camptosaurus (6 species)

Laosaurus (3 species

Dryosaurus sp.

Macelognathus sp.

Apatadon sp.

Brachyrophus sp.

Rhyncocephalia

Opisthias sp.

Crocodilia

Goniopnolis (3 species)

Chelonia

Compsemys sp.

Pterosauria

Dermodactylus sp.

Pisces

Ceratodus (3 species)

Appendix VII

Fossil fauna of Entrada Sandstone. Data from Baker, Dane, and Reeside (1936, p. 8).

"No fossils are known from the Entrada Sandstone except dinosaur footprints in the Moab Tongue at a locality 15 miles north of Moab, Utah".

Appendix VIII

Fossil fauna of Carmel Sandstone. Data from Gilully and Reeside (1927). Taxa known to occur in Kaiparowits Plateau Region (*).

Invertebrates

*Astarte sp.
*Camptonectes (5 species)
*Cardinia sp.
*Cardioceras sp.
Corbula sp.
Cyprina sp.
Dentalium sp.(?)
*Dosinia sp.
*Eumicrotis sp.
Gervilia sp.
Lima sp.
Lyosoma sp.
*Modiola (3 species)
Neritina sp.
*Ostrea sp.
*Pentacrinus sp.
Pholadomya sp.
Pinna sp.
Pleuromya sp.
Plicatula sp.
*Rhynchonella sp.
Serpula sp.
Tancredia sp.
*Trigonia (4 species)

Appendix IX

Fossil fauna recorded from Navajo Sandstone. Data from Brady (1935, 1936), Camp (1936), Breed (1968), and Galton (1971).

Vertebrates

Dinosaurs

- *Segisaurus* sp.
- *Ammosaurus* sp.
- Tracks

Invertebrates

Ostracods

Plant Material

Appendix X

Fossil fauna recorded from Moenkopi Formation. Data from McKee (1954).

Marine Fossils

Pelecypods

- *Pleurophorus* sp.
- *Schizodus* sp.
- *Bakewellia* sp.
- *Auiculopecten* sp.
- *Myalina* sp.
- *Pseudomonotis*(?) sp.
- *Monotis* sp.
- *Myophoria*(?) sp.

Ammonites

- *Meeuoceras* sp.
- *Tirolites spinosus*
- *Cordillerites* sp.
- *Hungarites*(?) sp.
- Orthoceratids

Crinoids

- *Isocrinus* sp.

Crustaceans

- *Halicyne* sp.
- Ostracods

Appendix X (cont'd)

Gastropods

- *Pleurotomaria* sp.
- *Natcopsis*(?) sp.

Worms

Non-Marine Fossils

Vertebrates

- Fishes
  - Paleoniscids
  - Dipnoans
  - Sharks
- Amphibians
  - *Metoposaurus frassi*
  - *Stanocephacosaurus birdi*
  - *Cyclotosaurus randalli*
  - *Rhadalognathus boweni*
  - *Aphaneramma*(?) sp.
  - *Capitosaurus*(?) sp.
  - *Parotosaurus peabodyi*
- Reptiles
  - *Anisodontosaurus greeri*
  - *Arizonasaurus babbitti*
  - Chirotherium tracks

Appendix XI

The following charts contain the rock layers (formations) that will be crossed by the transmission lines going from the Kaiparowits Power Plant to Eldorado (Northern Route). The environment of deposition, age and fossils present are given along with an estimate of the impact that the lines will have on each formation.

Appendix (cont'd)

MESOZOIC ROCKS

Formation	Environment of Deposition	Age	Fossils Present	Impact
Kaiparowits	Flood Plain, Fluvial Lacustrine	Upper Cretaceous	Dinosaurs and other Reptiles, Fish, Molluscs, Gastropods, Wood, Plant Remains	Medium-High
Wahweap	Flood Plain, Fluvial Lacustrine	Upper Cretaceous	Dinosaurs and other Retpiles, Fish, Fresh-water Gastropods, Ostracods, Pelecypods	Medium-High
Straight Cliffs	Fluvial, Near-shore, Marine	Upper Cretaceous	Vertebrate remains, Marine Invertebrates, Wood, Plant remains	Low
Tropic	Marine	Upper Cretaceous	Marine Invertebrates	Low
Dakota	Flood Plain, Fluvial, Lacustrine, Near-shore, Marine	Upper Cretaceous	Dinosaur and other Reptiles, Fresh-water Invertebrates, Plant remains	Low
Entrada	Aeolian	Jurassic	Dinosaur tracks	Low
Carmel	Nearshore Marine, Marginal Terrestrial	Jurassic	Marine Invertebrates	Low
Navajo Sandstone	Aeolian	Triassic Jurassic	Dinosaurs, Dinosaur tracks, Plant remains, Ostracods	Low
Kayenta Sandstone	Fluvial	Triassic	Dinosaur and other Reptiles, Dinosaur tracks	Low
Wingate Fm.	Aeolian	Triassic	Reptiles, Fish	Low

Appendix . (cont'd)

MESOZOIC ROCKS

Formation	Environment of Deposition	Age	Fossils Present	Impact
Chinle Fm.	Fluvial	Triassic	Dinosaur and other Worm Trails, Anthropods, Reptiles, Fresh-water Molluscs, Petrified wood, Plant remains, Amphibians, Fish, Ostracods, Branchiopods	Low
Moenkopi	Fluvial in east	Triassic	Reptile tracks, Molluscs, Amphibians, Fish	Low
	Fluvial, Marine to west	Triassic	Molluscs (Ammonites, Snails, Clams & Nautiloids)	Medium

Appendix I (cont'd)

PALEOZOIC ROCKS

Formation	Environment of Deposition	Age	Fossils Present	Impact
Kaibab Limestone Toroweap Fm.	Marine	Permian	Fish, Molluscs, Bryozoan, Sponges, Trilobites, Corals, Worms, Crinoids, Echinoids, Algae	Low
Coconino Sandstone	Aeolian	Permian	Reptile tracks, Invertebrate tracks	Low
Hermit Shale	Fluvial	Permian	Insects, Plant remains	Low
Supai Fm.	Fluvial, Marine	Permian-Pennsylvanian	Plant remains, Amphibian and Reptile tracks, Molluscs to the west	Low
Redwall Limestone	Marine	Mississippian	Molluscs, Corals, Trilobites, Crinoids, Bryozoans, Blastoids, Foraminifers, Fish, Ostracods	Low

Appendix XII

The following charts contain the rock layers (formations) that will be crossed by the transmission lines going from the Kaiparowits Power Plant via Moenkopi Substation to Mohave. The environment of deposition, age and fossils present are given along with an estimate of the impact that the lines will have on each formation.

Appendix I (cont'd)

MESOZOIC ROCKS

Formation	Environment of Deposition	Age	Fossils Present	Impact
Kaiparowits	Flood Plain, Fluvial Lacustrine	Upper Cretaceous	Dinosaurs and other Reptiles, Fish Molluscs, Gastropods, Wood, Plant Remains	Medium-High
Wahweap	Flood Plain, Fluvial Lacustrine	Upper Cretaceous	Dinosaurs and other Reptiles, Fish Fresh-water Gastropods, Ostracods, Pelecypods	Medium-High
Straight Cliffs	Fluvial, Nearshore, Marine	Upper Cretaceous	Vertebrate remains, Marine Invertebrates, Wood, Plant remains	Low
Tropic	Marine	Upper Cretaceous	Marine Invertebrates	Low
Dakota	Flood Plain, Fluvial, Lacustrine, Nearshore, Marine	Upper Cretaceous	Dinosaur and other Reptiles, Freshwater Invertebrates, Plant remains	Low
Entrada	Aeolian	Jurassic	Dinosaur tracks	Low
Carmel	Nearshore Marine, Marginal Terrestrial	Jurassic	Marine Invertebrates	Low
Navajo Sandstone	Aeolian	Triassic Jurassic	Dinosaurs, Dinosaur tracks, Plant remains, Ostracods	Low
Kayenta Sandstone	Fluvial	Triassic	Dinosaur and other Reptiles, Dinosaur tracks	Medium
Wingate Fm.	Aeolian	Triassic	Reptiles, Fish	Low

Appendix . (cont'd)

MESOZOIC ROCKS

Formation	Environment of Deposition	Age	Fossils Present	Impact
Chinle Fm.	Fluvial	Triassic	Dinosaur and other Worm Trails, Anthropods, Reptiles, Fresh-water Molluscs, Petrified wood, Plant remains, Amphibians, Fish, Ostracods, Branchiopods	Medium
Moenkopi	Fluvial in east	Triassic	Reptile tracks, Molluscs, Amphibians, Fish	Medium

Appendix VII (cont'd)

PALEOZOIC ROCKS

Formation	Environment of Deposition	Age	Fossils Present	Impact
Kaibab Limestone Toroweap Fm.	Marine	Permian	Fish, Molluscs, Bryozoan, Sponges, Trilobites, Corals, Worms, Crinoids, Echinoids, Algae	Medium
Coconino Sandstone	Aeolian	Permian	Reptile tracks, Invertebrate tracks	Low
Hermit Shale	Fluvial	Permian	Insects, Plant remains	Low
Supai Fm.	Fluvial, Marine	Permian-Pennsylvanian	Plant remains, Amphibian and Reptile tracks, Molluscs to the west	Low
Redwall Limestone	Marine	Mississippian	Molluscs, Corals, Trilobites, Crinoids, Bryozoans, Blastoids, Foraminifers, Fish, Ostracods	Medium
Temple Butte Limestone	Fluvial, Marine	Devonian	Armored Fish	Low
Muav Limestone	Marine	Cambrian	Trilobites, Sponges, Cystids, Gastropods	Low
Bright Angel Shale	Marine, Nearshore	Cambrian		Low
Tapeats	Littoral	Cambrian		Low

Appendix XIII

(To accompany Figs. 1 and 2)

The following list of localities (K-1 to K-9) represent those sites within the lease area or impact parimeter of the two proposed plant sites (Fourmile Bench Site-Fig. 1; and Nipple Bench Site-Fig. 2) where fossil material was either observed or collected. A list of the fossils thus far recorded from each locality is given. The reference numbers (eg. K-1) refer to field notes of Mr. Larry G. Marshall, Senior Paleontologist in charge of Phase I reconnaissance survey of these areas from August 5 to August 8, 1974. Field notes are on file in the Geology Department, Museum of Northern Arizona, Flagstaff.

Fourmile Bench Sites (Fig. 1)

K-1. Kaiparowits Formation. Just northwest of road approximately 30 yards north of SCE stake K-P-4, LS-3103. The matrix is a gray-green mudstone. Fragments of dinosaur bone, turtle shells, gar scales (Lepisosteus sp.), a reptile tooth, fish scales (not gar), and three species of gastropods (Campeloma sp., Goniobasis sp., and Planorbis sp.) were collected from this site. Fragments of fossil wood were also found in this area.

K-2. Wahweap Sandstone. Very fine, buff colored sandstone which forms cliff along top edge of canyon. A large palm(?) leaf was found here and the specimen measures 6 feet long and 3 1/2 feet wide. Fragments of this leaf were collected and the specimen was photographed. Pieces of fossil wood also occur in this area.

K-3. Kaiparowits Formation. Badland area of gray-green mudstones which are exposed along cliffs in amphitheatre on west side of road. Fossil wood, reptile bone fragments, gastropods, and fish scales were observed here.

K-4. Kaiparowits Formation. Coarse sandstone to conglomerate lenses are exposed on west side of road. These contain small fragments of reptile bone and fish scales.

K-5. Kaiparowits Formation. Coarse sandstone to conglomerate lenses occur in this area. These contain fragments of bone and fish scales.

K-6. Kaiparowits Formation. Coarse sandstone to conglomerate lenses occur in this area (similar if not identical to K-4 and K-5). Plant impressions and bone fragments are present.

Nipple Bench Site (Fig. 2)

K-7. Wahweap Formation. Coarse sand to gravel lenses which represent fresh-water channel deposits occur at this site in the uppermost cliff face. Large reptile bone fragments (some up to one foot in length) and crocodile teeth were observed to be abundant in these deposits. The channel deposits are lenticular but extend discontinuously along the entire cliff face. The impression of a leaf was found in a mudstone bed between two of these channel deposits.

K-8. Wahweap Formation. Fossil wood and bone fragments are abundant in this area. A small reptile tooth was collected from an anthill, and turtle and dinosaur bone fragments were also collected. There are channel deposits rich in bone as at site K-7, although here they occur as eroded caps on the hillocks which occur abundantly over the ground surface.

K-9. Wahweap Formation. Wood and bone fragments were observed coming out of a yellowish-green mudstone on the crest of a knoll at this site.

APPENDIX III-9

The Kaiparowits Project and its Impact on Growth in the Arizona and California Service Areas

APPENDIX III-9

ENVIRONMENTAL IMPACT STUDY FOR THE BUREAU OF LAND MANAGEMENT

THE KAIPAROWITS PROJECT AND ITS IMPACT ON GROWTH IN THE ARIZONA AND CALIFORNIA SERVICE AREAS

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September 21, 1974

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PREFACE

This report discusses some of the likely impact of the Kaiparowits Project on the service areas of the utilities that will receive electricity from the Project. The utilities are located in the states of Arizona and California: Arizona Public Service, Salt River Project, Southern California Edison, and San Diego Gas and Electric. The questions of whether the Project should be approved and the impact of the increased electricity on the utilities themselves are not of concern here. The primary interest of this report is with the likely impact of the increased electricity on the process of growth and urbanization in the service areas. And even more specifically the focus will be on three aspects of urban life as indicators of overall impact: open space (parks and recreation), pollution, and transportation.

The assumption is made that any population growth in the service areas will probably contribute to the already noticeable urban sprawl (actually suburban sprawl) in these areas. The report spends considerable time explaining the nature of the people, their governmental jurisdictions, and the likely population growth patterns in the service areas. In order to understand the impact of any continued growth some awareness of these features is a necessity. The report shows how different forecasts of future population growth rates affects both the need for more electricity as well as the services provided in the fields of open space, pollution abatement and transportation.

It is possible to argue that the availability of electricity from the Kaiparowits Project will cause continued growth in the service areas. Or to state the obverse, some have argued that without more electricity growth will not and can not occur once the electric utilities reach their current system capacity. To say the least, this issue is complicated, and no definitive answer can be given here. In addressing this issue one must consider, at a minimum, all alternative sources of energy and their availability and impact on population growth. No evidence has been found to suggest that trends in population growth will be determined by the availability of electricity. There can be no question, however, that the availability of electricity will help influence the pattern of population growth, commercial/industrial growth and facilities such as parks, pollution abatement and transportation in the service areas. For the purposes of this report it will be assumed that population will grow in the service area and any increase in available electricity will facilitate the growth. The impact of this growth on open space, pollution abatement, and transportation is affected by not only the pattern of the growth but electrical energy availability. As the report will show increased electrical energy will be necessary if certain policies in the open space, pollution abatement, and transportation fields are enacted. (A subsequent section details the current status of population forecasts.)

The report is organized into three sections. First, a description of the demographic and governmental characteristics of the service areas is presented; this is coupled with a discussion of projections for population growth and growth in the demand for electricity in the service areas. Second, the three topics of open space, pollution, and transportation are discussed in terms of both the recent history of these issues and current plans for the future in the service areas. Third, a summary and conclusion will discuss the projected impact of continued growth and urbanization in the service areas and the likelihood of problem solving efforts being adopted and being successful.

At the outset an important qualification is in order. The subject dealt with here is extremely complex and it deserves much thought and extensive further research. Nevertheless, by limiting the study to only specified aspects of the entire, potential set of issues certain conclusions can be reached. Data on electricity consumption and forecasts of electricity demand came primarily from the utilities involved in the Kaiparowits Project. Efforts have been made to verify the accuracy of such data whereever possible.

I. Characteristics of Service Area in California and Arizona and Patterns of Electrical Consumption

DESCRIPTION OF SERVICE AREA
IN CALIFORNIA AND ARIZONA

Service Area versus Impact Area in Southern California

The impact area is that part of the total SCE and SDG&E service area which will be studied in this report. The impact area consists of Los Angeles, Orange, Riverside, San Bernardino, Ventura and San Diego counties.

Thirteen California counties and even a small part of the state of Nevada lie within the Southern California Edison service area. San Diego Gas & Electric serves almost all of San Diego County and the southern portion of Orange County. The area varies from the mountainous country around the Sierra Nevadas in Inyo and Mono Counties to the dry desert of San Bernardino and Riverside Counties. (See Maps of Service Area and Population Distribution.)

However, it would be an exaggeration to claim that the Kaiparowits Project would exercise a significant impact over the enormity of this entire area. Some of the counties within the service area are sparsely populated, and others are serviced by another utility as well as by SCE. This is reflected in Table 1 which lists the counties serviced by SCE. Only that part of the population serviced by SCE in each county is included. (For example, the population of the city of Los Angeles is not included because the Los Angeles Department of Water and Power serves all of the residents of that city.)

Clearly, the Kaiparowits Project would have a far more significant impact on those counties which represent the largest segments of Edison's total service area. The combined population of the five largest counties within the SCE service area constitutes 93.4% of the total number of people within the service area. This can be seen from the cumulative listing in the Table. These counties -- Los Angeles, Orange, San Bernardino, Ventura, and Riverside -- would be the ones within the SCE service area most likely to be affected by the Kaiparowits Project. In addition, San Diego county, served by San Diego Gas and Electric, would also likely be affected by the project as it, too, represents a sizeable population. Because of the almost perfect correlation between population and the amount of residential kilowatt-hour sales, and because of the high correlation between population and the amount of commercial and industrial kilowatt-hour sales, we can assume that these five counties accounted for roughly the same percentage of SCE's and SDG&E's total electrical demand.

Thus, these six counties will be referred to as the "impact area" for the project (in California) and the study will concentrate on the impact of the Kaiparowits Project on this area.

Table 1

Counties Within the SCE Service Area (1970)*

County	The County's population as a percentage of total population in entire SCE service area		
Los Angeles	56.4	93.4%	Impact Area
Orange	17.8		
San Bernardino	9.6		
Ventura	5.6		
Riverside	4.0		
Tulare	2.4		
Santa Barbara	2.3		
Kern	1.1		
Kings	.4		
Nevada (state of)	.2		
Fresno	.1		
Inyo	.1		
Mono	.1		
Imperial	.003		

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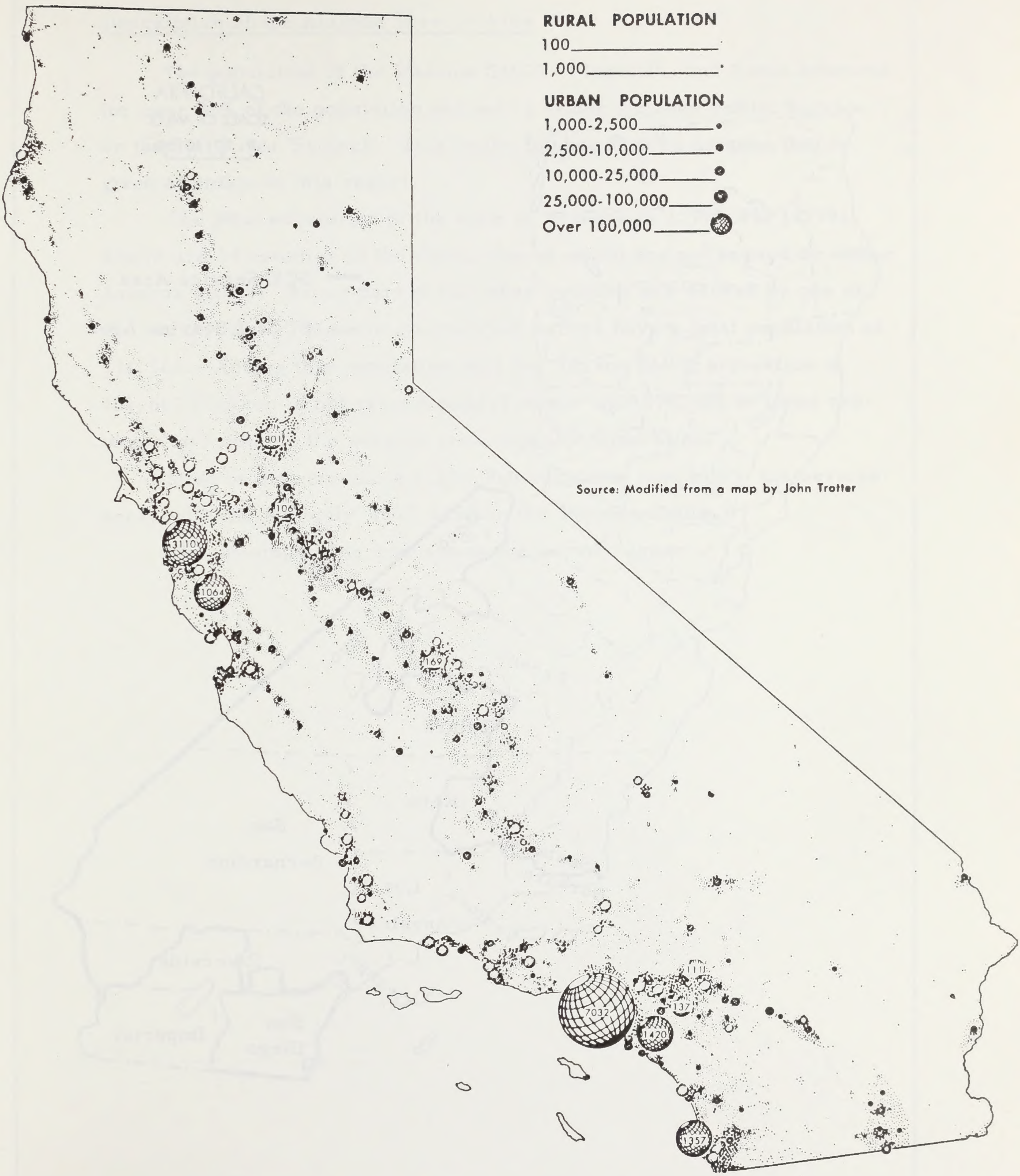
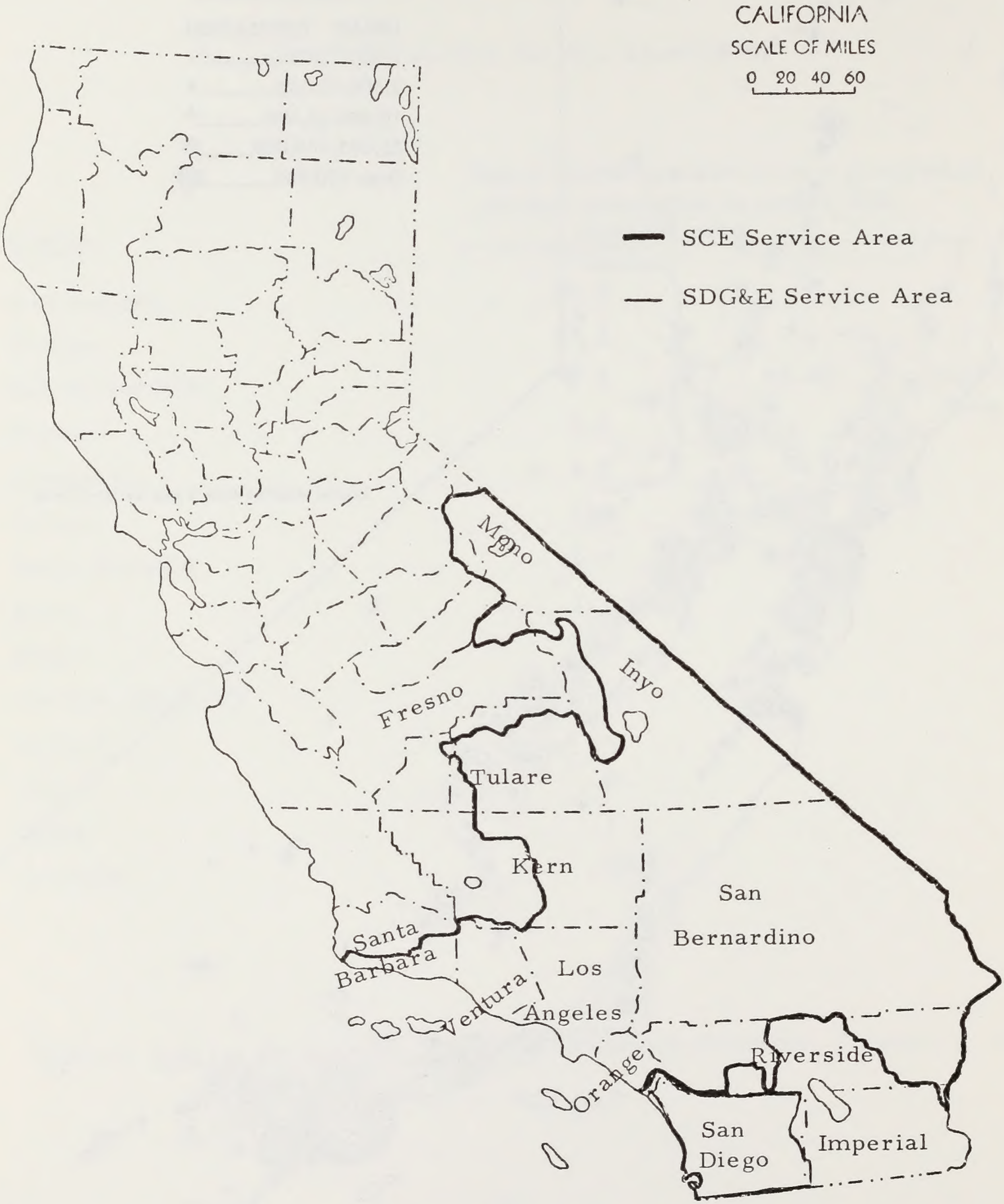
*Source: System Forecasts: 1973-1995 (Southern California Edison), p. II-6



Source: Modified from a map by John Trotter


CALIFORNIA
SCALE OF MILES
0 20 40 60
SCE Service Area
SDG&E Service Area
Mono
Inyo
Fresno
Tulare
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial

Description of the Arizona Service Area

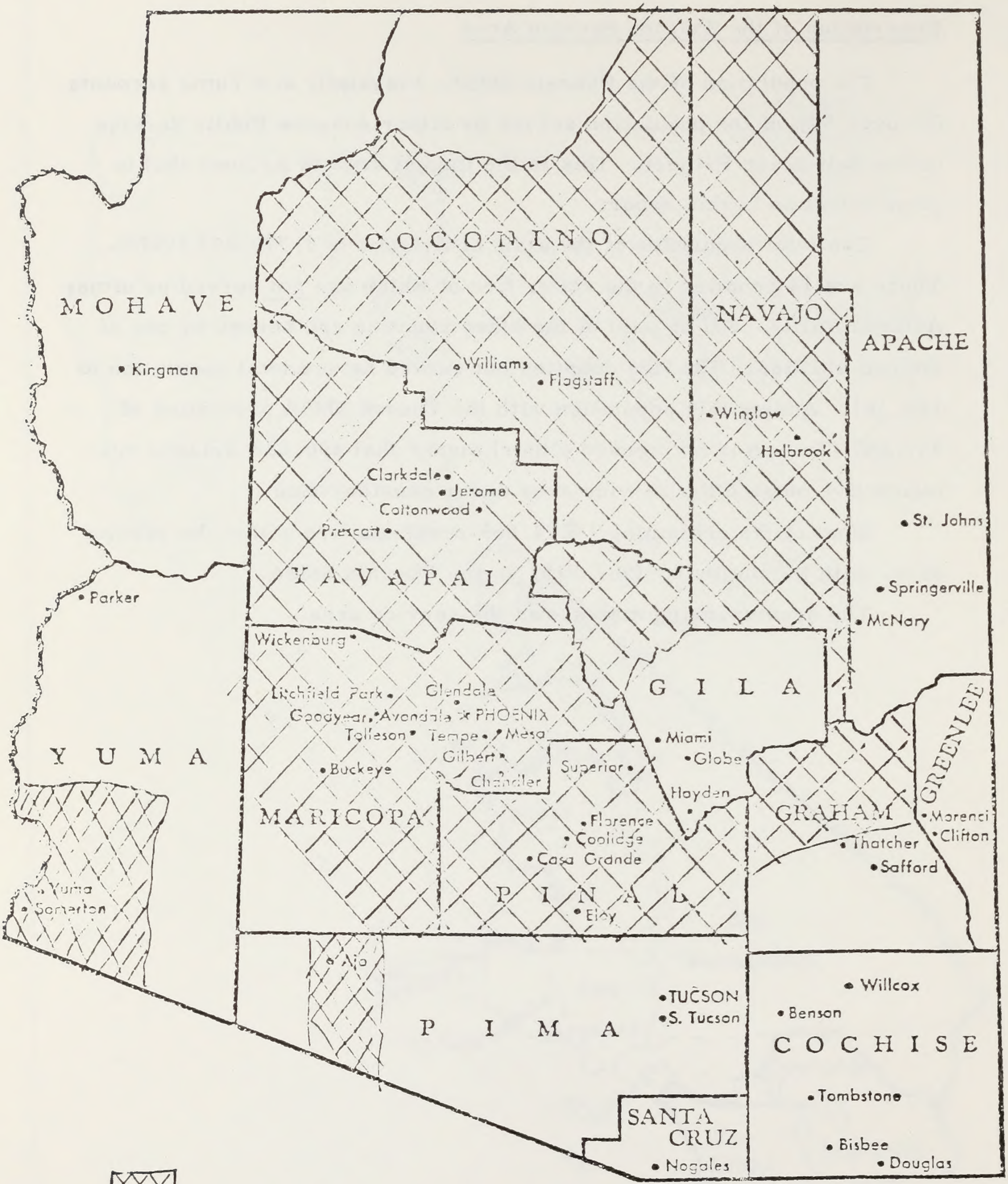
The population of the Phoenix SMSA, Flagstaff, and Yuma accounts for over 80% of the population served by either Arizona Public Service or the Salt River Project. This is the impact area in Arizona that is given attention in this report.

The total population of the state of Arizona is 1, 770, 893 (1970). There are 14 counties in the state, five of which are not served by either Arizona utility. All or part of the other counties are served by one of the two utilities. The five counties not served have a total population of 144, 361. Adding this population with the Tucson SMSA population of 351, 667 (Tucson is not served either) means that 496, 028 Arizona residents live outside the service area under consideration.

Most of the remaining 1, 274, 865 residents live within the service area, with the majority (967, 515) in the Phoenix SMSA.

The accompanying map shows the service area.

County Map of Arizona



▨ Service Area of Arizona Public Service and Salt River Project

Table 1A

Shares of Kaiparowits Electricity as a Percentage of Company Estimates of Demands

	MW from Kaiparowits	Expected from Kaiparowits 1980 as percent of peak demand*	Expected from Kaiparowits 1982 as percent of peak demand*
Arizona Public Service Co.	540	16%	14%
Salt River Project	300	12%	10%
San Diego Gas & Electric Co.	702	22%	19%
Southern California Edison Co.	1,200	7%	6%

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*Demand estimated by utilities.

CHARACTERISTICS OF SERVICE AREA IN CALIFORNIA

Basic Demographic Characteristics

The basic demographic characteristics of the impact area are presented in Table 2. The area served by Southern California Edison and San Diego Gas and Electric is dominated by Los Angeles, Orange, and San Diego counties. These three counties are the most heavily populated in the state. Los Angeles county is the most populous county in the country; Orange county is the thirteenth most populous county in the country; and San Diego county is the fifteenth most populous county in the country. Smaller counties in the SCE and SDG&E service area, like tiny Mono county with only about 4000 inhabitants, are dwarfed by comparison and are not included in this report.

While 90.9% of the people in California live in urban areas, 98.8% of the inhabitants of Orange county, 98.7% of the inhabitants of Los Angeles county, and 93.5% of the inhabitants of San Diego county live in urban areas. The state's patterns of population density and urbanization are also reflected by the amount of land that has recently been taken out of agricultural production. In the five years from 1964 to 1969, the state experienced a net loss of 3.5% of its farm land to other purposes, but Orange county lost 24.3% of its farm land and San Diego county lost 11.5% of its farm land.

The high rate of migration into Southern California in the past decade accounts for this increasing urbanization. From 1960 to 1970 the state experienced a net in-migration of 13.4%. But Orange county experienced a net in-migration of 78.3%, and Ventura county experienced a net in-migration of 66.2%. Thus, while Los Angeles county held fairly steady, experiencing a net in-migration of only 4.2%, its neighbors to the South and North registered whopping increases. In assessing the future demand for electricity, a question which must be asked is whether other areas in Southern California will become as densely populated as Los Angeles and Orange counties?

Because different types of housing units use different amounts of electricity, housing patterns must also be taken into account when assessing future demand for electricity. Single unit housing uses more electricity than multiple family dwellings. Sixty-seven percent of the people in the state live in one-unit structures. While roughly the same percentage of the inhabitants of Orange and San Diego counties live in one-unit structures, a slightly smaller percentage in Los Angeles county live in one-unit structures. As a county becomes more densely populated, it would be expected that a smaller percentage of people in the county would live in one-unit structures.

Table 2

Demographic Characteristics of Counties Served by SCE and SDG&E

(Source: 1970 Census)

	population per square mile	1970 population	birth rate per 1000 population (1968)	net migration (1960-1970)	population in urban areas	land in agricultural use
	persons		births	%	%	%
State	128	19,957,715	17.5	13.4	90.9	35.7
Los Angeles	1,730	6,993,371	18.1	4.2	98.7	21.4
Orange	1,817	1,409,359	18.2	78.3	98.8	36.7
Riverside	64	449,878	16.7	36.8	78.6	13.6
San Bernardino	34	672,163	18.1	20.8	89.8	16.4
San Diego	319	1,351,135	17.0	16.4	93.5	22.6
Ventura	203	374,520	17.8	66.2	92.4	36.3

Table 2 (cont'd)

	change in amount of land in agricultural use (1964-1969)	change in farm population (1960-1970)	population in one-unit structures	per capita income
	%	%	%	dollars
State	-3.5	-44.7	67.0	3,614
Los Angeles	-4.7	-61.7	60.6	3,864
Orange	-24.3	-93.6	68.1	3,872
Riverside	-15.2	-51.6	75.1	3,083
San Bernardino	17.8	-37.5	82.0	3,002
San Diego	-11.5	-44.4	67.7	3,381
Ventura	-1.0	-50.4	80.0	3,246

Table 2 (cont'd)

	sex	- race -					median
				of Spanish		median	years
	female	white	black	surname	other	age	educated*
	%	%	%	%	%	years	years
State	50.8	not available				28.4	12.4
Los Angeles	51.6	67.1	10.8	18.3	3.7	29.6	12.4
Orange	50.9	86.0	.7	11.3	2.0	26.2	12.6
Riverside	51.0	75.8	4.6	17.3	2.2	29.7	12.3
San Bernardino	50.6	77.8	4.2	16.0	2.0	26.8	12.2
San Diego	48.2	79.4	4.6	12.8	3.2	25.6	12.4
Ventura	50.3	76.4	1.7	19.6	2.3	25.1	12.4

*of persons 25 and older.

Table 3

Population Growth in Impact Area

1950 - 1970

	1950 population	1970 population	% increase
Los Angeles	4,151,687	6,993,371	68.4
Orange	216,224	1,409,359	551.8
Riverside	170,046	449,878	164.6
San Bernardino	281,642	672,163	138.7
San Diego	556,808	1,351,135	142.6
Ventura	114,647	374,520	226.7
Total	5,491,054	11,250,426	104.8

Population Growth

Table 3 shows that the population in Impact area has more than doubled since 1950. There are many conflicting projections concerning population growth in California; unfortunately it cannot be said that any one of them is clearly more authoritative than the others. However, based on the demographic projections which we have studied, we believe that a birth rate somewhere between 2.1 and 2.5 births per woman of childbearing age (between series E and D) is likely, and an annual net migration of 100,000 into the state appears reasonable.

Projected patterns of population growth throughout the Southern California area are currently in a state of flux. There is no agreement over the extent to which the Southern California population can be expected to grow in the next twenty or thirty years. Due primarily to changing social attitudes concerning the desirable number of children per family and the role of women in society, population projections of only a few years ago have been discarded in favor of projections which reflect these changed attitudes and which consequently project a lower rate of population growth. But current population projections reflect these changing attitudes to differing degrees. In this period of transition, there is considerable variability among the population projections issued by governmental agencies and utility companies.

A growth rate following the "D-100" series assumes a birth rate of 2.5 births per woman of childbearing age and a net migration of 100,000 people per year into the state. A growth rate of "E-O" assumes a birth rate of 2.1 births per woman of childbearing age and a net migration of zero per year into the state.

The following table indicates the series currently being used by the California Department of Finance (DOF), the California Public Utilities Commission (CPUC), the Rand Corporation, the Southern California Association of Governments (SCAG), Southern California Edison (SCE), and the San Diego Gas & Electric Company (SDG&E).

DOF	D-100 is their "baseline" series. They use E-0, D-150, and C-150 as alternative series.
CPUC	CPUC uses a combination of series D and E, varying according to the geographical area. CPUC does not indicate what net in migration it expects.
Rand	In a study dated September, 1972, Rand used the D-150 series, but they are in the process of switching to the E-100 series. (Private communication with Dr. Ronald Doctor, Sept. 10, 1974)
SCAG	SCAG uses a combination of the E-) and D-150 series. (In their terminology this is referred to as a "DE2a" series.) However, SCAG is in the process of switching to another series which is also a combination of the D and E series, but which is closer to the E series than is their DE2a series. (This new series is referred to as their "FEB Delphi" series.)
SCE	SCE uses the E-100 series.
SDG&E	SDG&E uses the D-100 series.

Using these series, the following population projections have been made for the year 1990:

	County					
	Los Angeles	Orange	Riverside	San Bernardino	San Diego	Ventura
DOF (D-100)	7,347,000	2,465,000	756,000	914,000	2,242,000	704,000
DOF (E-0)	6,571,000	2,195,000	681,000	826,000	2,044,000	602,000
SCAG (DE2a)	7,701,000	2,240,000	765,000	1,065,000		835,000
SCAG (FEB Delphi)	7,452,000	2,074,000	700,000	911,000		643,000
SCE (E-100)				917,000		770,000
SDG&E (D-100)					2,242,000	

CPUC and Rand do not issue county-by-county population projections. The SCAG area does not include San Diego county. The population projections of SCE are based on their service area within a county rather than on the entire county. All of Los Angeles, Orange, and Riverside counties are not within the SCE service area. Therefore the SCE population projections for its service area within these counties are not comparable to the DOF and SCAG population projections, which are for the entire county. However, all of Ventura and San Bernardino counties are within the SCE service area, and therefore SCE's projections for these two counties are comparable to the projections of DOF and SCAG.

As can readily be seen, there is a wide degree of variance between these projections. Compounding the confusion is the fact that different assumptions concerning population distribution within Southern California are apparently being made even when there is agreement concerning the rate of population growth in Southern California. For example, the following population projections for Ventura county for the year 1990 seem to reflect different assumptions concerning the nature of population distribution and net migration:

DOF (E-0)	602,000
DOF (D-100)	704,000
DOF (D-150)	731,000
DOF (C-150)	750,000
SCE (E-100)	770,000

Southern California Edison's E-100 series, which is based on an expected birth rate of 2.1 (the level which in the long run would result in zero population growth) and an expected annual net migration of 100,000 persons into the state, yields a higher projected population than the Department of Finance's E-0 series, which would be expected, but it also yields a higher projected population than the Department of Finance's D-100 series, which would not have been expected. And most perplexing is the fact that SCE's E-100 series yields a higher projected population even than the Department of Finance's

C-150 series, which is based on an expected birth rate of 2.8 and an expected annual net migration of 150,000 persons into the state. The Department of Finance's C-150 series is its highest plausible alternative. The discrepancy between the DOF and SCE projections must be due to different assumptions concerning out of state and intra-state migrants within Southern California. Specifically, the discrepancy must be due to different assumptions concerning the extent of migration into Ventura county.

There is a similar, though much less marked, discrepancy for San Bernardino county for the year 1990.

DOF (E-0)	826,000
DOF (D-100)	914,000
DOF (D-150)	927,000
DOF (C-150)	953,000
SCE (E-100)	917,000

The SCE E-100 series yields a higher projected population than does the DOF D-100 series. Again, the Department of Finance and Southern California Edison must be making different assumptions concerning population distribution.

Urban and Suburban Growth

Urbanization is a phenomenon that is quite familiar to contemporary America, and especially to Southern California. The most noticable, and probably the most important, national demographic trend of the post WWII era is the increasing concentration of people in urban areas. This has produced a decrease in the percentage of the population that lives in small towns or rural areas; fewer and fewer people escape the influence of urban life.

Urban areas are characterized by life styles, housing patterns, and work experiences that differ from rural attributes. Urbanites are a highly interdependent group, requiring cooperation of many different people in order that their daily life can proceed; the trucker, grocer, policeman, shoe salesman and many others play a role in determing the nature of an urban residents' life and behavior patterns. By definition urban areas are more densely settled, with people living closer together than in rural areas. The United States Bureau of the Census defines an urban area as any place having at least 2500 people. This definition does not agree with most common sense attitudes about what constitutes an urban place. An urban area is usually felt to be part of a larger metropolitan area. In this report urban refers to communities in a metropolitan region.

Within urban areas there is typically a separation between place of residence and place of employment. Nowhere is this fact of more consequence for both private citizens and those who make public policy than in Southern California. The enormous degree of reliance upon automobiles to move from residence to employment and from residence to necessary goods and services has had a major impact on the character of Southern California. For example, Los Angeles County alone has over 20,000 miles of highways and streets.

In Southern California the urbanization process has been dominated by the desire to sprawl and to avoid the extremely high density living that is found in many other American urban centers. In this sense Southern

California has been suburbanizing and not urbanizing. Suburban life has many of the attributes of urban life style mentioned above, but it is usually characterized by a higher percentage of middle and upper income groups with a high percentage of single-family homes and a desire for lower population density than is found in the central city area.

Southern California, especially the Los Angeles area never developed a high density core area surrounding the industry and commercial which provided employment. Los Angeles, epitomized the post-automobile city. It is a region. Spread out over a very large area, both the Los Angeles and San Diego regions have a lower population density (people per square mile) than most metropolitan centers in the nation, despite their large populations. (Los Angeles County covers 4,069 square miles and San Diego is spread over 4,261 square miles.)

Whatever the level of population growth that occurs in Southern California it will contribute to the outward movement; no large scale migrations back into the "downtown" or "central" areas is foreseen. The suburban growth of the last two decades took place into areas that were either agricultural or previously barren but now habitable because of imported water supplies. There is no indication of any change in the pattern of sprawl.

Having just made such a prediction it is appropriate to point out the complexities involved in forecasting trends in urban development. In order to understand urban growth patterns one should study such variables as the location of new growth in relation to existing communities, the type of planning control in the area, the level of quality standards required in new construction, the degree of public subsidies in new urban development and the nature of social class and racial integration. Taking this incomplete list of variables and realizing that each of these variables has several possible values points out the enormous number of logically possible combinations that might represent the form of future urban growth.

In the face of this complexity this report makes some simplifing assumptions. We assume that the suburbanization process of the last few decades in Southern California, characterized by continued suburban sprawl with reliance upon single family housing, will dominate whatever growth occurs in the area. The sprawl, of whatever magnitude, will occur in the midst of relatively unplanned, uncoordinated growth policies with relatively little regional public control over the exact nature of the sprawl.

Governmental Jurisdictions

Within the six county high impact area, responsibility for the performance of local government functions is quite fragmented. In addition to the county governments, numerous cities and special districts exercise jurisdiction. For instance, during the 1971-72 fiscal year in Los Angeles County over 340 special districts performed local government functions. Approximately one half of these districts were governed by the county Board of Supervisors, but the remainder were controlled by separately elected boards of directors. In addition, there are 77 cities within Los Angeles County, each making decisions about the cost of public services and the kind of community life styles that will predominate.

Some cooperation between these governmental entities can be seen. In fact, cooperative arrangements are common and Southern California has been a pioneer in the use of the so-called "Lakewood Plan" whereby independent cities and special districts contract with another governmental entity, usually the County, for the performance of certain services.

Despite the cooperation, the fragmentation of decision making authority within the area means that no coherent, comprehensive plan for future growth is being implemented on an area wide basis. The Southern California Associations of Governments (SCAG) is an association of the counties of Los Angeles, Orange, Riverside, San Bernardino, Ventura, and Imperial and most of the cities within these counties. The San Diego

Comprehensive Planning Organization is a similiar group. These regional planning associations have been developing area-wide plans in transportation, open space, population growth forecasting, and other areas. So far very little implementation on a region-wide basis has taken place. Some planning may take place at a regional level, but political control remains highly decentralized and fragmented.

Any discussion of future growth and its impact in Southern California must take into account these facts: fragmented government, some regional planning but little regional implementation of plans, and different local preferences for growth. Some areas within the service areas continue to be receptive to the traditional American growth ethic -- growth is necessary and proper. Other communities have been recently expressing doubt about the inevitability and desireability of continued growth. The clash between these contending viewpoints is probably the major feature of local politics within the impact area under consideration. Some communities may decide to limit or even stop growth and to that extent the suburbanization process will be changed in its rate and character. Although there are some strong anti-growth sentiments in the area, there is no indication that efforts by some localities to control growth more stringently than before will have a major impact on the area in the near term future.

CHARACTERISTICS OF SERVICE AREA IN ARIZONA

The combined service area of Arizona Public Service and the Salt River Project covers most of Arizona and includes Arizona's largest metropolitan area (Phoenix). Tucson is the second largest city in Arizona but it is not served by these utilities. Next to Phoenix, the two largest communities in Arizona served by utilities participating in the Kaiparowits Project are: Yuma and Flagstaff.

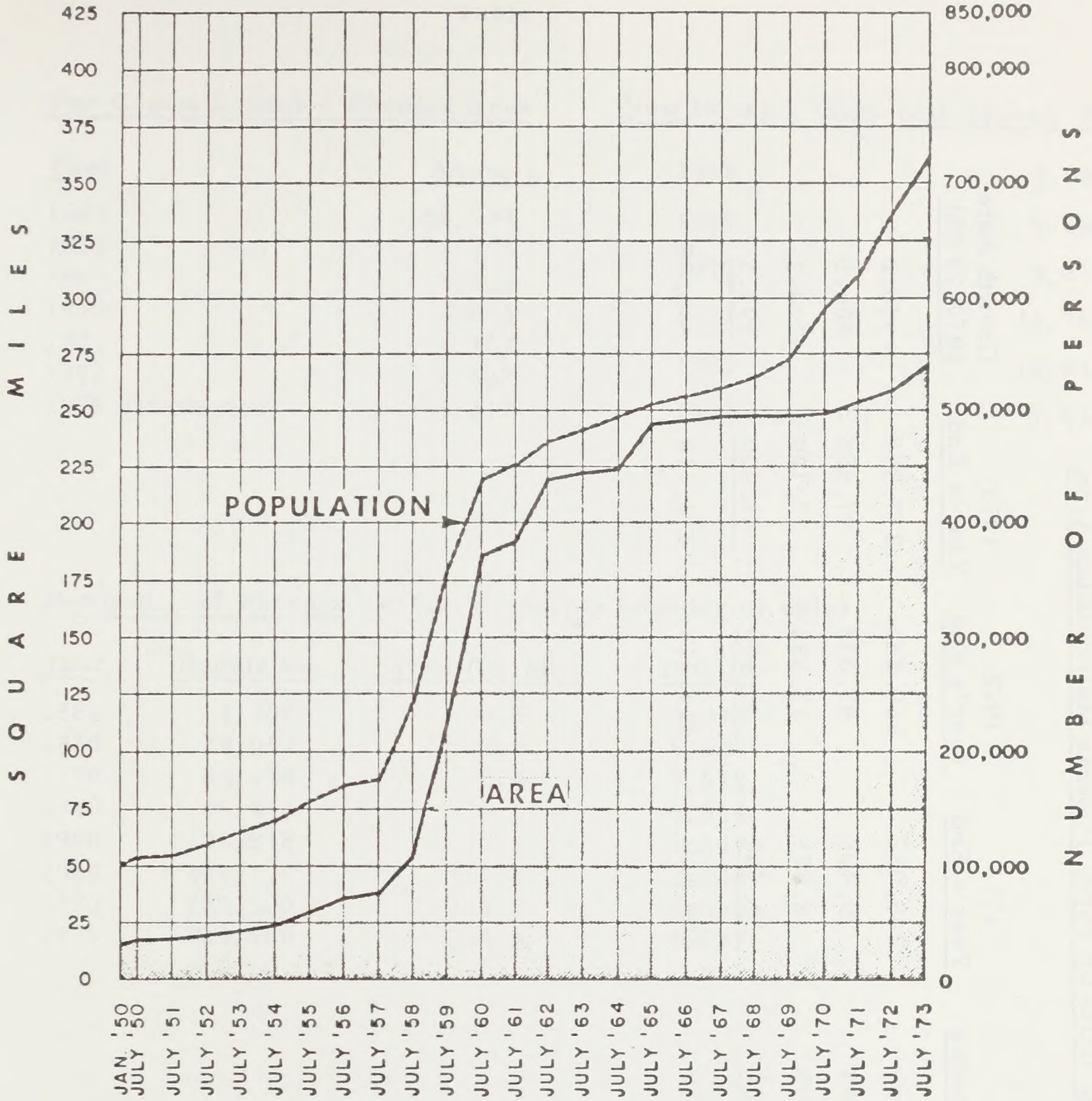
Yuma is located 138 feet below sea level in the extreme southwest corner of the state. The city was officially established in 1854, but its history goes back to the Spanish conquistadores and missionaries. Its principle economic activities are agriculture, livestock, tourism, light industry, and it is the seat of Yuma county government. There has been a 21% population increase from 23, 974 in 1960 to 29, 007 in 1970. Yuma is rapidly becoming a city in which agricultural enterprises are being replaced by industrial concerns.

Flagstaff is the hub of trade and economic activity for northern Arizona. It is located in the pine forested area of northcentral Arizona. Lumbering, tourism, retail and wholesale trade, and education make up its economic base. Flagstaff was incorporated as a town in 1894 and as a city in 1928. There has been tremendous growth since 1950. The city's population rose from 18, 214 in 1960 to 26, 117 in 1970, an increase of 43.4%.

Phoenix was not the most important urban center in Arizona until it became the capital city of the Territory in the late 19th century. After that the city experienced continued rapid growth. Today, Phoenix has a population of over 743, 000. With a total city area of 269 square miles, its population density comes to 2, 687 persons per square mile. This figure is rather misleading, however, for much of this land area is vacant. One of the largest city parks in the nation, South Mountain Park, covers 16, 000 acres of the total land area. See Chart 1.

Chart 1

PHOENIX GROWTH



YEAR	POPULATION NO. OF PERSONS	AREA SQUARE MILES
JANUARY 1, 1950	102,548	16.4
JULY 1, 1950	107,116	17.1
JULY 1, 1951	108,158	17.1
JULY 1, 1952	119,000	18.9
JULY 1, 1953	129,956	21.0
JULY 1, 1954	140,062	24.1
JULY 1, 1955	155,788	29.0
JULY 1, 1956	170,082	35.7
JULY 1, 1957	172,569	36.3
JULY 1, 1958	241,899	52.6
JULY 1, 1959	360,771	110.0
JULY 1, 1960	439,671	187.4
JULY 1, 1961	451,964	191.1
JULY 1, 1962	468,385	220.3
JULY 1, 1963	482,521	222.6
JULY 1, 1964	494,061	222.7
JULY 1, 1965	504,448	245.7
JULY 1, 1966	511,238	246.2
JULY 1, 1967	519,006	247.4
JULY 1, 1968	527,774	247.7
JULY 1, 1969	546,381	247.7
JULY 1, 1970	589,374	247.9
JULY 1, 1971	620,750	254.9
JULY 1, 1972	674,000	258.2
JULY 1, 1973	723,700	269.3

Table 4

Growth of Housing Units by Type, Phoenix Metropolitan Area

Type	1970 Census	1971 Year's End	1972 Year's End	1973 Year's End	Growth Rate 1970-73 (%)
Single Family	231,363	249,037	269,246	277,998	+20.2
Multiple Units	58,564	79,408	93,338	97,583	+66.6
Townhouses/Condomin.	5,630	8,675	13,334	17,129	+204.2
Mobile Homes	21,422	32,700	38,400	41,400	+93.3
Total	316,989	369,820	414,318	434,110	+36.9%

Table 5

Per Capita Income - Phoenix Area

Year	Amount
1967	$2,934
1968	3,195
1969	3,537
1970	3,841
1971	4,167
1972	4,522
1975 (Projected)	5,217

New Housing Units (All Types), Phoenix

1968	5,741
1969	9,556
1970	9,213
1971	13,769
1972	16,834
1973 (June 30)	7,636

Population of Phoenix (within corporate boundaries only)

Year	Population	Area (Sq. Mi.)	Density
1881	1,708	0.5	3,416
1920	29,053	5.1	5,697
1930	48,118	6.4	7,518
1940	65,414	9.6	6,814
1950	106,818	17.1	6,247
1960	439,170	187.4	2,344
1970	582,500	247.9	2,350
1973	723,700	269.3	2,687

Today a variety of economic factors are important in Phoenix including tourism, electronic appliance manufacturing, government, light industry, retail and wholesale trade, and construction. Phoenix has long offered the business and industrial community of the Southwest an attractive tax structure, making for a large growth in industry during the past two decades. "Open shop," and "right to work" legislation, requiring that no employer in the state restrict employment to union members has helped keep employee salaries and wages relatively low and has helped increase the number of industries attracted to the city of Phoenix. Due to this growth, job opportunities have expanded and per capita income has risen. The unemployment rate in Phoenix (3.7% in 1970) is fairly stable from year to year, usually paralleling the national average.

With the increased urbanization and industrialization of Phoenix the concurrent growth of the nearby surrounding smaller cities was stimulated. By 1970, the Phoenix Standard Metropolitan Statistical Area (SMSA), including the cities of Phoenix, Glendale, Tempe, Mesa and Scottsdale, had a combined total population of 811,373.

According to the 1970 U.S. Census, the Phoenix SMSA had a total population of 811,373. Of this total, 83% (674,590) were classified as white: 13% (107,379) were classified as Spanish language or surname; and 4% (29,404) were classified as blacks. (Other racial categories occurred in such small quantities as to be insufficient to quantify separately.) Although Arizona has a large Indian population most of them live on reservations or in towns in northern Arizona and New Mexico close by the Navaho reservation.

PROBLEMS IN FORECASTING ELECTRICAL ENERGY CONSUMPTION PATTERNS

For illustrative purposes the problem of forecasting electrical demand in the SCE and SDG&E service areas will be examined here. The Arizona utilities experience similar problems.

In assessing consumption forecasts by the participating utilities it is essential to understand that all such predictions are necessarily problematical. There is, at present, no one forecasting methodology employed by all utilities -- or even by most utilities. Therefore, it is not surprising that one may find dissimilar projections being made about essentially similar areas.

Also, all demand projections affect the actual energy demand. That is, if utilities underestimate projected demand and only provide the amount of electricity estimated, actual demand will obviously be curtailed so that it matches that predicted. (An outcome requiring changes and perhaps inconvenience for electrical consumers.) Conversely, if demand is overestimated and increased electricity is available for consumption, utilities may curtail conservation efforts and thereby stimulate demand to the anticipated levels. In a very real sense, demand forecasts are important determinants of actual consumption rather than the other way around. As the Federal Energy Administration has stated, because demand forecasts tend to be self-fulfilling "it is not possible to verify adequately the validity of critical assumptions upon which projections are based."

The problematical character of demand forecasts are even more accentuated due to the changing consumption patterns that have been occassioned by the energy crisis and the resulting increases in the real price of electricity. This has lead residential, industrial, and commercial customers to institute some kind of energy-saving program, be it simply turning off unused lights or replacing some energy intensive machinery with human labor. Regardless of the method used, electricity customers cut their consumption in order to offset rising costs and diminished supplies. This has lead utility forecasters to reduce their prior estimates of demand, although the exact amount of change varies from utility to utility. Clearly, prior projections based on virtually unlimited resource supplies are being scraped in favor of more conservationally-minded estimates. But because the utilities (and the customers) have found themselves in a vastly different situation than that predicted, the precise nature of future demand in a resource-scarce era is still unknown.

Consumption Forecasts for Southern California Edison Service Area

The area served by Southern California Edison is the most heavily urbanized of the participating utilities in the Kaiparowits Project. Prior projections of annual peak demand constructed by SCE were predicated on a growth rate of over 9% in electrical consumption. However, current predictions place the consumption growth rate at a much lower level, somewhere around 5% -- depending upon which current projection is utilized. So dramatic has been the decline in expected consumption growth rates, SCE has prepared two different, although not disparate, forecasts about expected increases in demand. To illustrate the rapidly changing nature of demand forecasting, the following table compares the 1973 estimates concerning consumption in 1983 with the current 1974 forecast:

Projections for 1983

	1973 Forecast	1974 Forecast	% Reduction
Annual Peak Demand	18,990 (MW)	16,300 (MW)	14.1
Residential Per Capita	9,685 (Kwh)	7,795 (Kwh)	19.6
Residential Sales	28,330 (Kwh)	24,140 (Kwh)	12.4
Commercial Sales	29.880 (Kwh)	19,860 (Kwh)	26.3
Industrial Sales	27,350 (Kwh)	22,970 (Kwh)	16.0

(See Figures 1-6 for more complete breakdown.)

Not only do prior projections overestimate long range electricity consumption, SCE projections for 1974 are inflated compared to actual consumption for the first seven months. According to the California Public Utilities Commission, SCE 1972 projections for 1974 averaged over 18% higher than actual consumption. A monthly breakdown on the reduction achieved this year is presented in the following table:

SCE Reduction in Sales Compared to 1972 Projections

	Dec 1973	Jan	Feb	Mar	April	May	June	July
Residential	8.6	15.5	17.5	18.4	16.7	17.2	12.6	6.4
Commercial	13.8	14.4	16.7	19.6	19.1	17.4	17.5	12.7
Total	16.4	13.4	21.7	22.0	20.1	19.3	19.9	10.7

(See Figure 6) (Data on industrial conservation not available)

While these reductions in consumption have been impressive, it is important to note that the total percentage decrease appears to have leveled off or declined somewhat as is shown by the July reduction figures. Furthermore, the latest figures received from SCE show that the total percentage reduction in sales for August 1974 was 11.7% giving additional support to the idea that percentage reductions in consumption has stabilized.

It bears repeating that predictions about future demand based on the experience of the first seven months of this year cannot be considered highly reliable. As yet SCE has not had sufficient time to determine whether these reductions have long range significance or are merely momentary responces to the shortages experienced earlier this year. For example, according to the table presented above, residential conservation has fallen rapidly since the beginning of the summer, indicating that residential customers may be returning to their prior consumption patterns. Commercial customers, on the other hand, have been able to maintain a fairly high level of conservation, which suggests that firms have been able to institutionalize energy saving programs into their daily operations. If these inferences are correct, then it would appear that the residential sector is the most volatile and unpredictable of the three major users of electricity.

Whether or not current consumption reductions will be maintained depends on many variables and assumptions -- only a few of which will be identified here. One of the most important factors is future governmental and utility policy toward conservation. In part the decline in consumption conservation shown above is attributable to a relaxation of the California Public Utility Commission standards on utility conservation programs, moving from mandatory to voluntary compliance. In turn, the utilities have relaxed their customer conservation requirements thereby giving rise to increased consumption. If state and federal agencies resume their strict standards on consumption, one should expect a continued reduction in electrical usage comparable to that achieved so far this year. This is not to say that total kilowatthour sales or peak demand will not increase, but that they will not increase at the rate previously forecast. However, there are a number of mitigating factors which could offset any decrease in consumption due to stringent conservation measures.

First, it has been predicted that during the latter quarter of this century there will be a serious shortage in natural gas, the major competing source of energy, which will result in an increased reliance on electricity and a decline in mixed utility customers. According to SCE predictions, "due to uncertainty of gas supply to large interruptible users, an increasing number of commercial and industrial customers will consider electricity to be a feasible alternative." This prediction is borne out by San Diego Gas and Electric Company forecasts which estimate that unless new reserves of natural gas are discovered soon, they will have to impose a moritorium of all new gas hookups. However, these predictions have been challenged by the Rand Corporation who claim that synthetic gas will replace diminishing natural gas supplies so that gas will remain a competitive energy alternative.

Second, housing patterns and building construction standards affect electrical consumption. It is estimated that apartments and condominiums consume one third less electricity for heating and cooling purposes than do single unit residences. With respect to construction standards, the Federal Energy Administration estimates that the capital outlay required to generate 10 kilowatts of electricity is substantially greater than that required to install proper insulation which would reduce heating/cooling requirements by the same amount. Improved building standards, therefore, would substantially reduce expected demand.

Third, there is expected to be an increasing number of households relative to total population increases. That is, even though population is expected to grow at a lower rate, the size of the average household is expected to decrease thereby creating more households per total population than has traditionally been the case. An increasing household formation rate will mean that there will be an increase in the number of dwellings per population and an increased number of utility customers. Currently, SCE predicts that the average household contains 3.04 persons -- by 1995, this is expected to decline to 2.78 members per household.

Fourth, the availability and use of time-saving electrical appliances is expected to increase. In the residential sector, SCE estimates a moderate growth in appliance saturation -- not only will more households own more electrical appliances, but household members are expected to replace existing appliances with ones which consume greater amounts of electrical energy (eg. from black and white televisions to color sets; from conventional refrigerators to frost free refrigerators; from conventional ovens to self-cleaning ovens). The current level of appliance saturation is subject to varying interpretations. To give some idea of the importance which appliance saturation levels play in estimates of total residential sales, SCE estimates that per capita kilowatthour sales will be 15,939 by the year 2000. The Rand Corporation, on the other hand, only predicts sales to be 11,500, the difference between these two figures largely varying with one's estimation of the appliance saturation levels.

A more accurate picture of consumption patterns in the service area of Southern California Edison can be seen in the electric consumption of the three largest user types -- residential, commercial, and industrial. As the following table indicates, the commercial and residential sectors are expected to increase in their share of total SCE sales, with commercial sales increasing throughout the rest of the century and residential sales leveling off and declining somewhat during the 1990's. Throughout the period industrial sales have steadily decreased from a high of 38% to an expected share of only 23.8% by 1995. The increase in commercial and residential sales and the corresponding decrease in industrial sales indicate that the Southern California area is moving to a more service oriented economy. No doubt part of the reasons for declining industrial sales is due to the more stringent environmental standards which now apply to the Southern California area. The fact that the Federal Energy Administration doubts that the Kaiparowits generating plant could be constructed in Southern California because it could not meet air pollution control standards illustrates the restrictions placed on heavy industry. Only the mining sector (principally oil drilling) is expected to show any substantial increases throughout the rest of the century, for obvious reasons.

Net Edison Kilowatthour Sales
By Customer Classification

(As A Percentage of Total Kilowatthour Sales)

Year	Residential	Commercial	Industrial
1955	19.7	13.2	--
1960	21.0	18.1	38.0
1965	23.7	19.7	36.8
1970	24.3	22.0	35.0
1975	25.4	24.6	32.0
1980	26.4	26.9	26.9
1985	26.9	29.1	25.3
1990	26.4	31.2	24.3
1995	25.4	33.4	23.8

(Estimates for 1975-1995 provided by SCE)

Whether consumption will grow at the rates forecasted cannot be determined. There is great potential for electrical conservation in the commercial and residential sectors but whether such savings will be realized depends upon the complex interplay between governmental and utility conservation policies and customer consumption patterns.

San Diego Gas and Electric

The area served by San Diego Gas and Electric comprises most of San Diego County, an area which is currently one of the fastest growing areas in California. SDG&E predicts a rather substantial influx of new customers during the rest of the century. This is evidenced by the fact that SDG&E still forecasts future population growth on a D-100 series while SCE employs the lower E-100 series.

It is difficult to fully assess SDG&E predictions about future growth because of the particular methodology they employ in determining their future demand. For instance, SDG&E forecasts do no distinguish between industrial and commercial electricity sales. In addition, multi-meter apartment buildings are also included within the commercial sales category, thereby making the commercial classification encompass a wide diversity of economic activities.

Also, while SDG&E has revised their 1974 forecast downward by some 23% over their 1973 predictions, their methodology for accounting for this "conservation factor" is not wholly satisfactory. Their method amounts to subtracting 1284 million kilowatthour from total kilowatthour sales for each year predicted. SDG&E's 1978 demand projections have been reduced by 1284 million kilowatthours just as have been their 1995 projections even though the 1995 total is over twice as large as their 1978 projection. Because of this, one would expect that if 1284 million kilowatthour "conservation factor" is appropriate for 1978, an even larger figure would be more realistic for 1995. However, it must be noted that all utilities are currently faced with consumer behavior which has called into question traditional assumptions about growth and demand.

As has already been stated, SDG&E predicts a substantial increase in electricity demand throughout the rest of the century. But as Figure 7 shows, SDG&E's predictions about population growth does not account for the size of the increase predicted. For example, SDG&E's forecast for 1974 states that 1612 megawatts will be required to meet the demands of a service area comprising 1,528,000 people. If the same megawatt demand per population ratio were maintained for 1985, then the 3612 megawatts predicted would meet the demand of a population of 3,612,000 instead of the 2,000,000 actually predicted. Therefore, SDG&E predicts a very substantial growth in the per capita consumption level. As Figure 8 illustrates, per capita consumption is expected to increase 62% between 1973 and 1985.

Whether or not such an increase in per capita consumption will occur is dependent upon several assumptions already discussed with respect to Southern California Edison's forecast. The most important of these assumptions is that the supply of natural gas will rapidly diminish within the near future resulting in a moritorium on future hookups and perhaps curtailment of existing services. The effect of this will be a rather substantial switch to complete reliance on electricity thereby increasing per capita consumption.

Although predictions concerning commercial per capita consumption are not available, it seems that the per capita consumption in this sector will not rise as quickly as in the residential sector. This inference is made on the basis of the data contained in Figure 9 which shows that the residential sector will consume an increasing share of the total kilowatt-hour sales -- moving from 39% of the total sales to 47%, while commercial sales decline from 57% in 1978 to around 50% in 1995. Considering the broad range of consumers which are placed in the commercial sector, it is significant that the residential sector is forecast to consume such a large share of the total electrical demand. From this, it seems that a great deal of residential growth is expected to take place in the SDG&E service area. It appears that the San Diego County area will be a primarily service-oriented one, with relatively little heavy industry moving into the area.

FIGURE 1 (SCE)

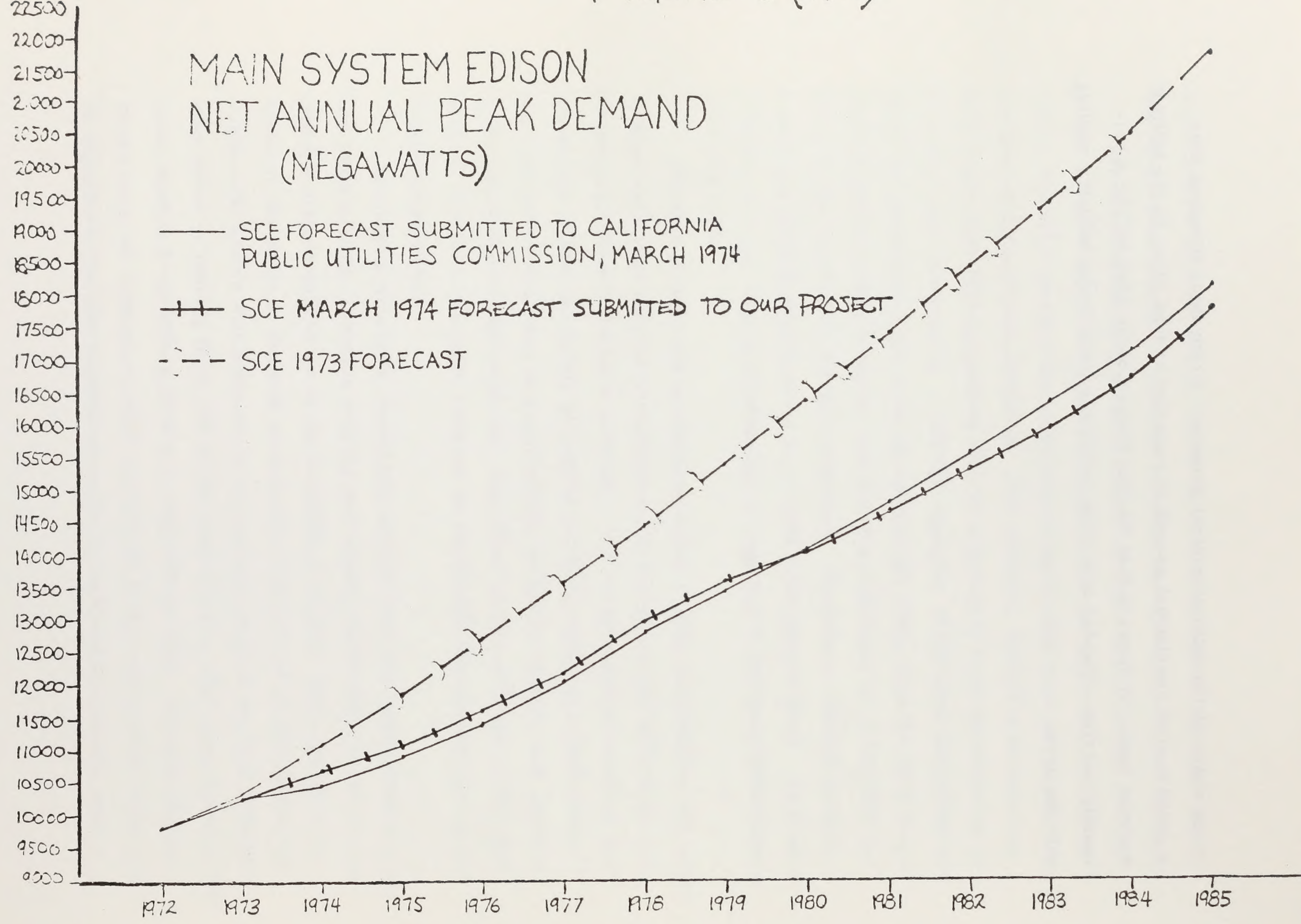

MAIN SYSTEM EDISON
NET ANNUAL PEAK DEMAND
(MEGAWATTS)
SCE FORECAST SUBMITTED TO CALIFORNIA PUBLIC UTILITIES COMMISSION, MARCH 1974
SCE MARCH 1974 FORECAST SUBMITTED TO OUR PROJECT
SCE 1973 FORECAST
22500
22000
21500
21000
20500
20000
19500
19000
18500
18000
17500
17000
16500
16000
15500
15000
14500
14000
13500
13000
12500
12000
11500
11000
10500
10000
9500
9000
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985

FIGURE 2 (SCE)

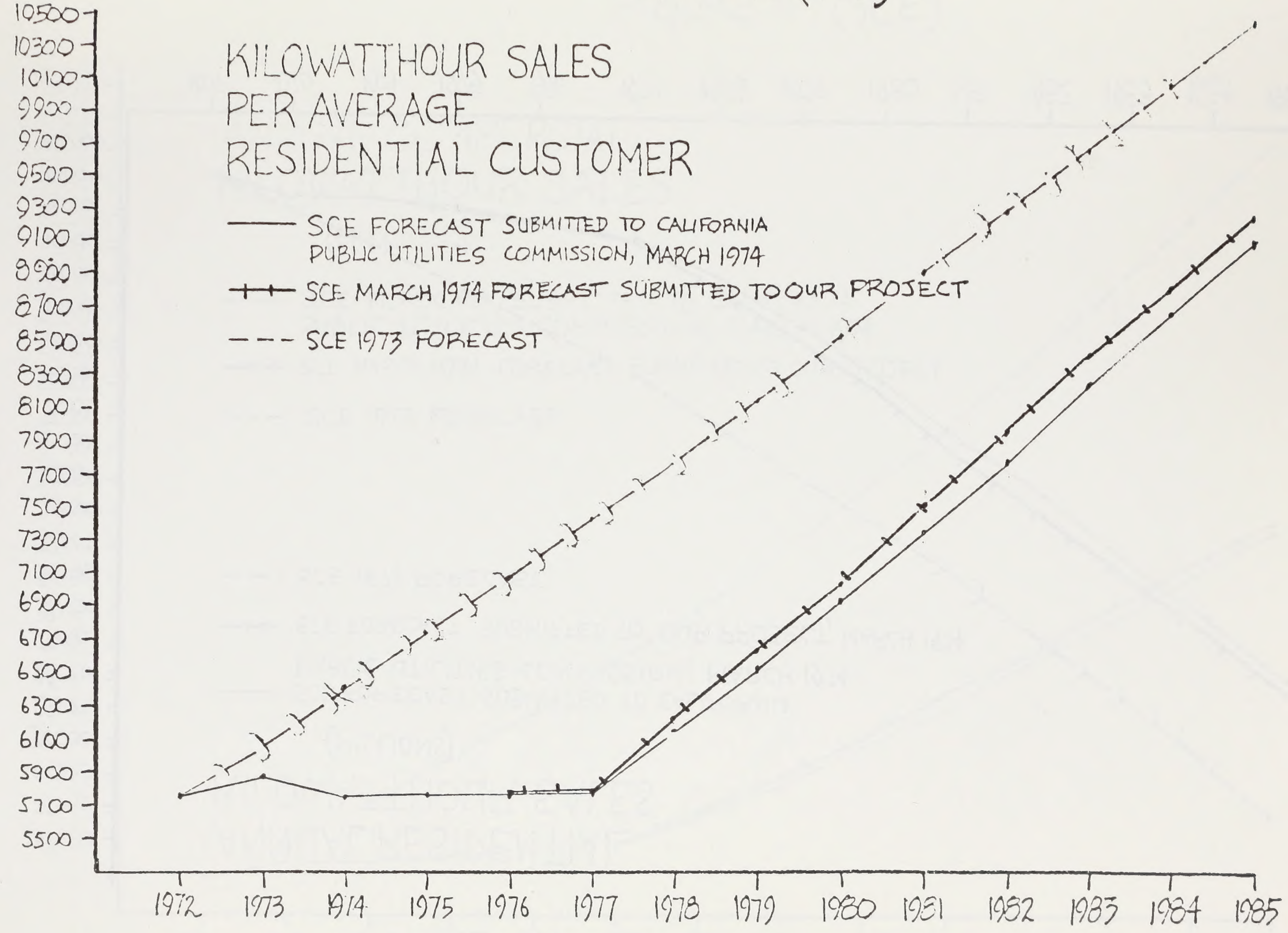

KILOWATTHOUR SALES
PER AVERAGE
RESIDENTIAL CUSTOMER
SCE FORECAST SUBMITTED TO CALIFORNIA PUBLIC UTILITIES COMMISSION, MARCH 1974
SCE MARCH 1974 FORECAST SUBMITTED TO OUR PROJECT
SCE 1973 FORECAST
10500
10300
10100
9900
9700
9500
9300
9100
8900
8700
8500
8300
8100
7900
7700
7500
7300
7100
6900
6700
6500
6300
6100
5900
5700
5500
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985

FIGURE 3 (SCE)

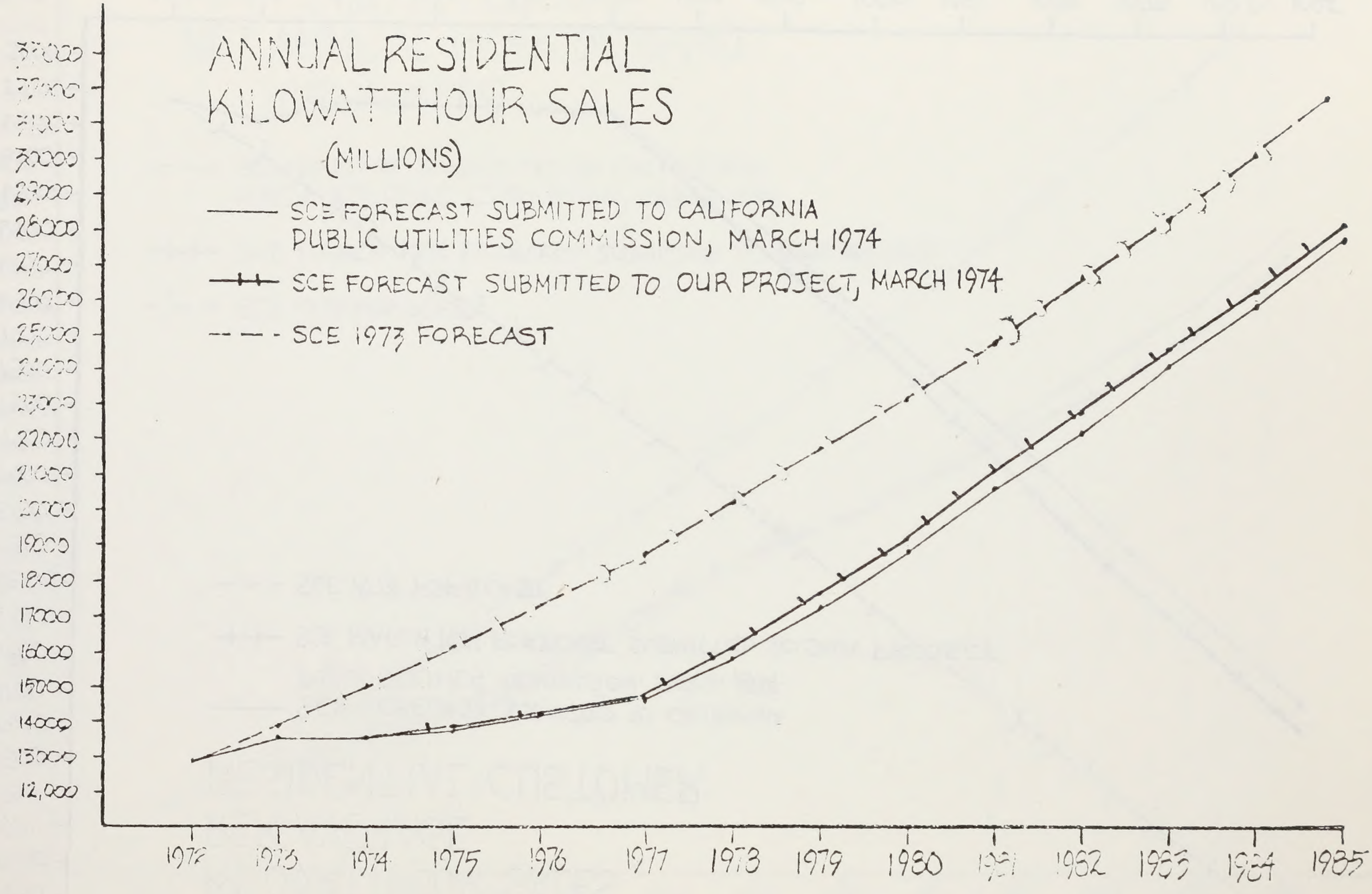

ANNUAL RESIDENTIAL
KILOWATTHOUR SALES
(MILLIONS)
SCE FORECAST SUBMITTED TO CALIFORNIA PUBLIC UTILITIES COMMISSION, MARCH 1974
SCE FORECAST SUBMITTED TO OUR PROJECT, MARCH 1974
SCE 1973 FORECAST
33000
32000
31000
30000
29000
28000
27000
26000
25000
24000
23000
22000
21000
20000
19000
18000
17000
16000
15000
14000
13000
12,000
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985

FIGURE 4 (SCE)

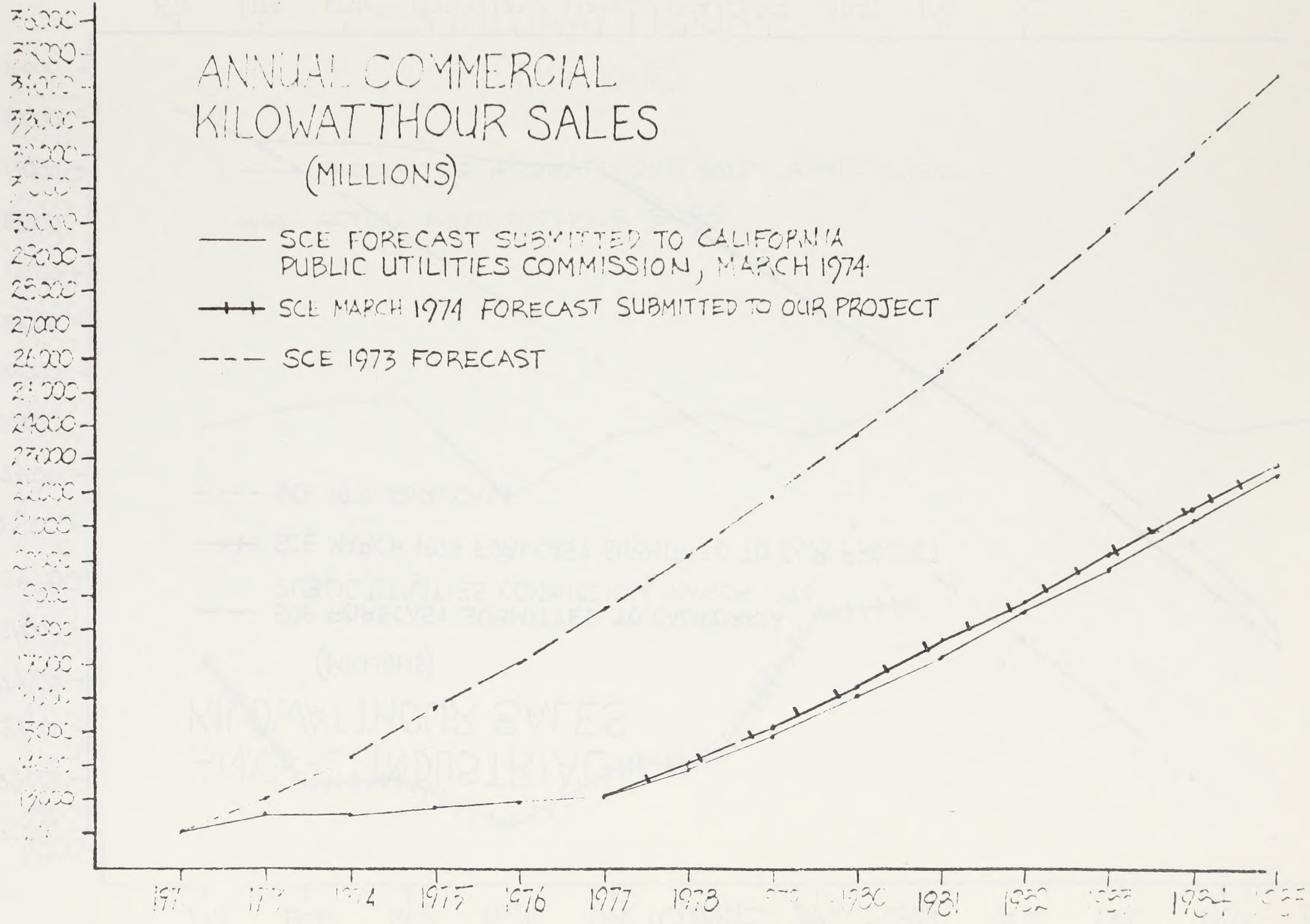

ANNUAL COMMERCIAL KILOWATTHOUR SALES
(MILLIONS)
SCE FORECAST SUBMITTED TO CALIFORNIA PUBLIC UTILITIES COMMISSION, MARCH 1974
SCE MARCH 1974 FORECAST SUBMITTED TO OUR PROJECT
SCE 1973 FORECAST
36000
35000
34000
33000
32000
31000
30000
29000
28000
27000
26000
25000
24000
23000
22000
21000
20000
19000
18000
17000
16000
15000
14000
13000
12000
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985

FIGURE 5 (SCE)

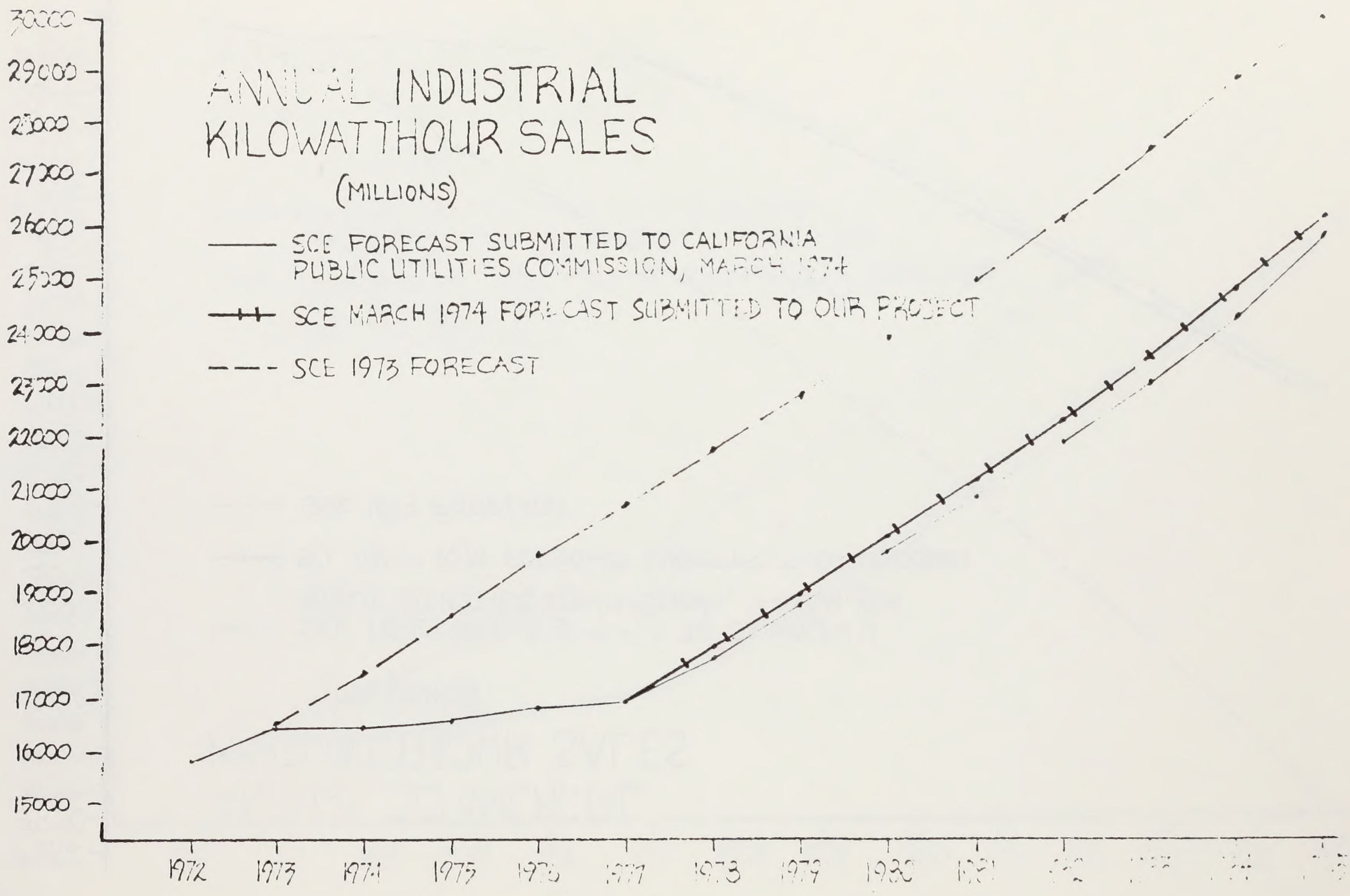

ANNUAL INDUSTRIAL
KILOWATTHOUR SALES
(MILLIONS)
SCE FORECAST SUBMITTED TO CALIFORNIA PUBLIC UTILITIES COMMISSION, MARCH 1974
SCE MARCH 1974 FORECAST SUBMITTED TO OUR PROJECT
SCE 1973 FORECAST
30000
29000
28000
27000
26000
25000
24000
23000
22000
21000
20000
19000
18000
17000
16000
15000
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985

FIGURE 6 (SCE)

ACTUAL SALES COMPARED TO PROJECTED SALES FOR 1974
KILOWATTHOUR
(MILLIONS)

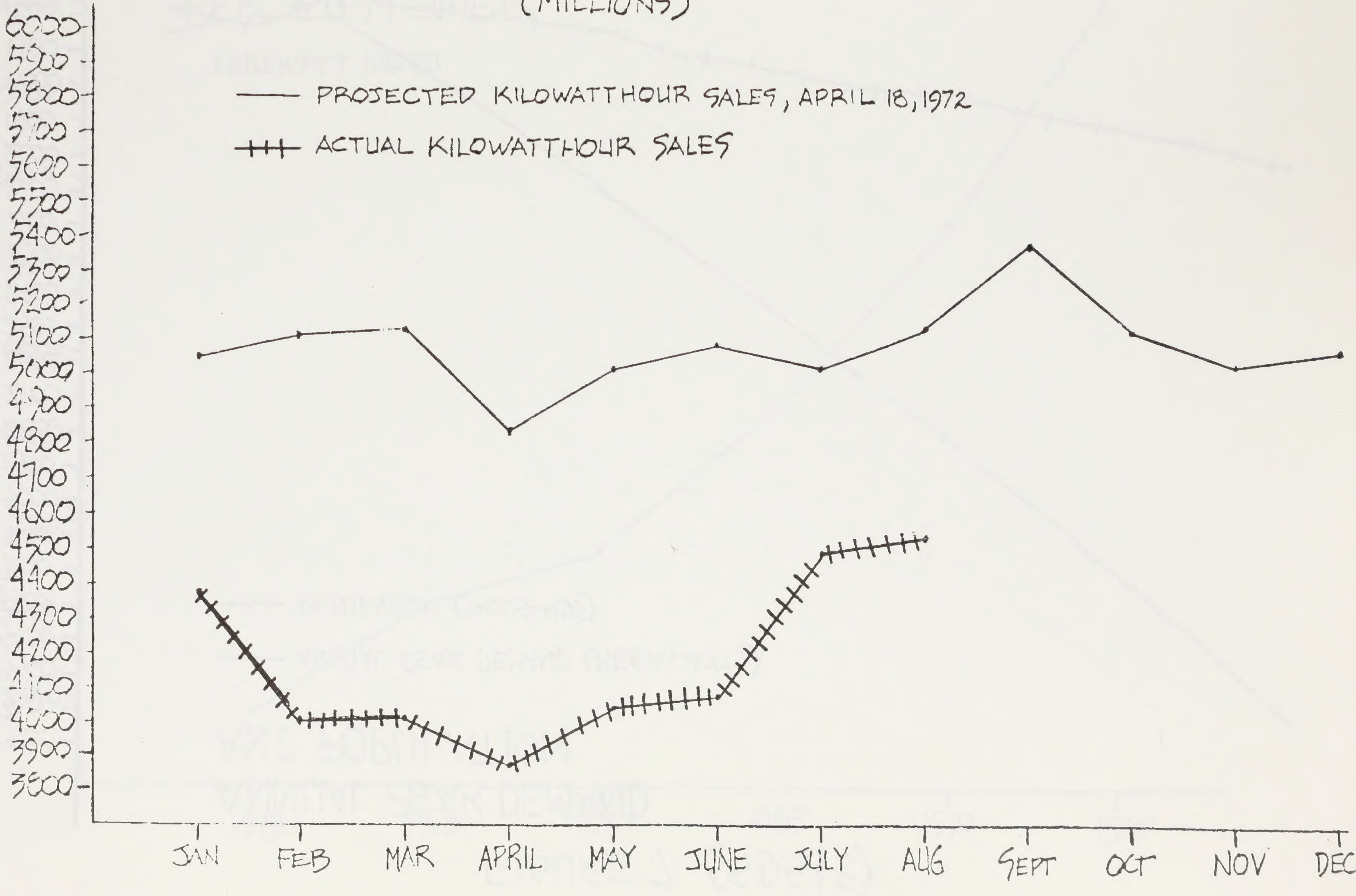


FIGURE 7 (SDG&E)

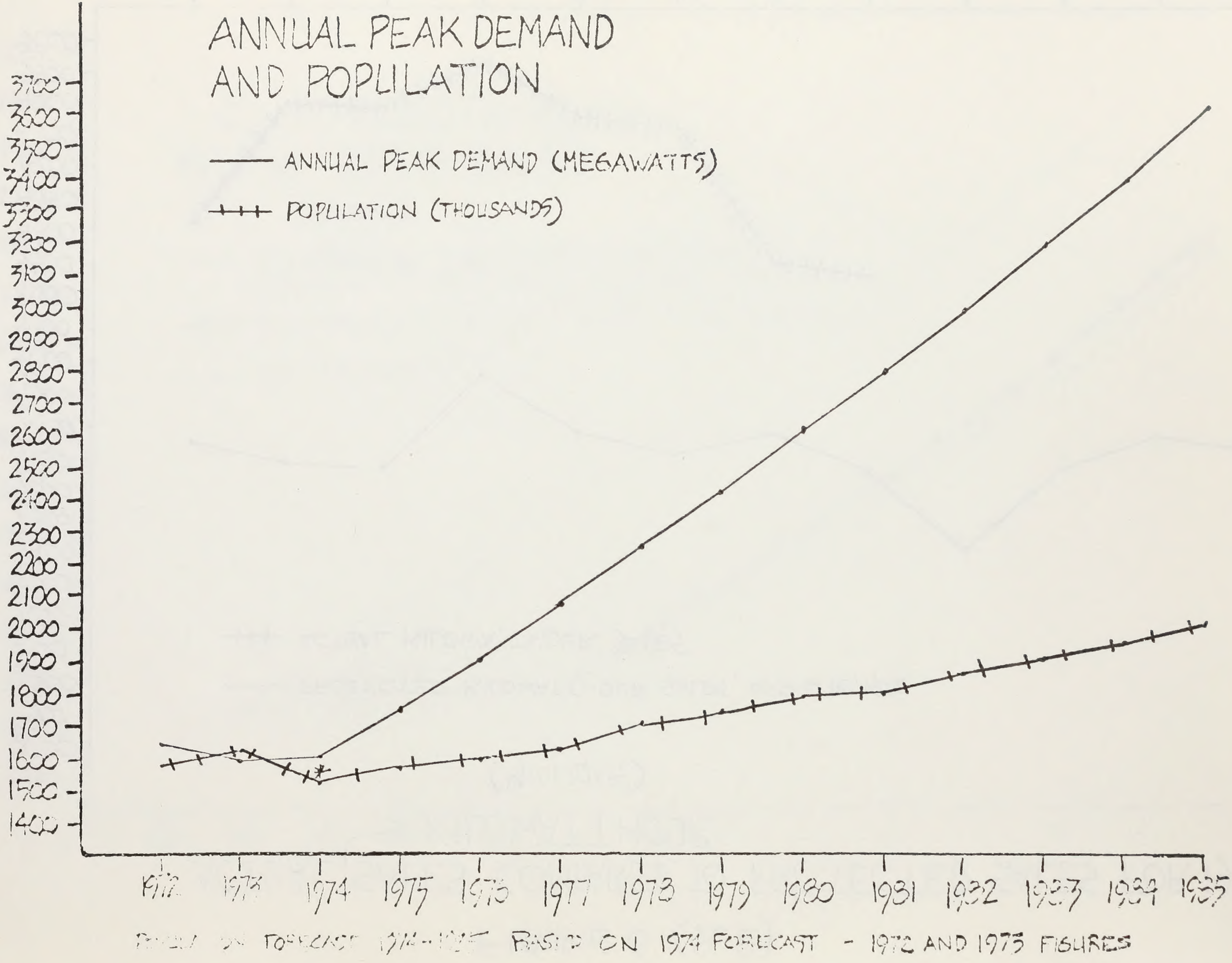


FIGURE 8 (SDG&E)

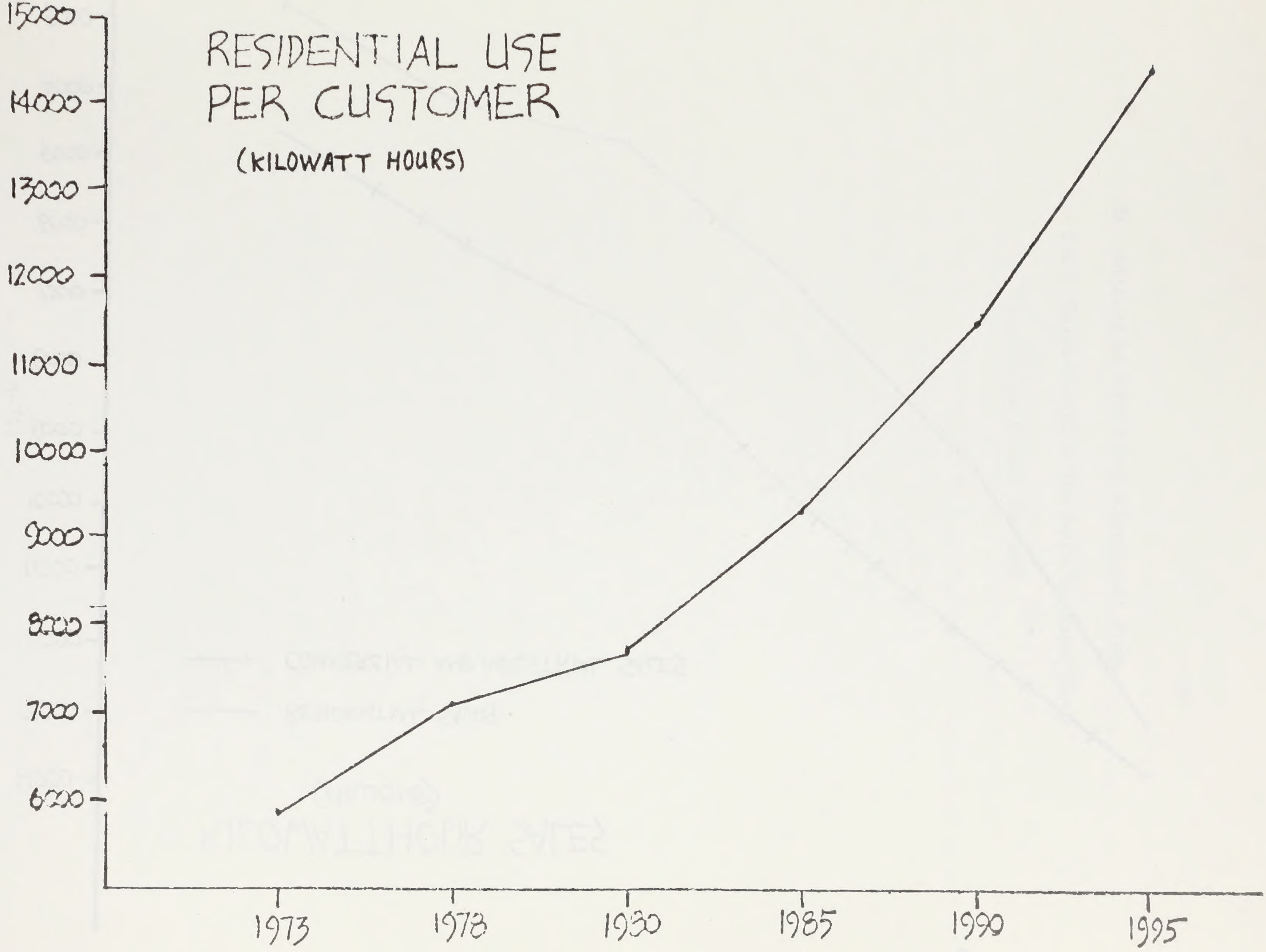
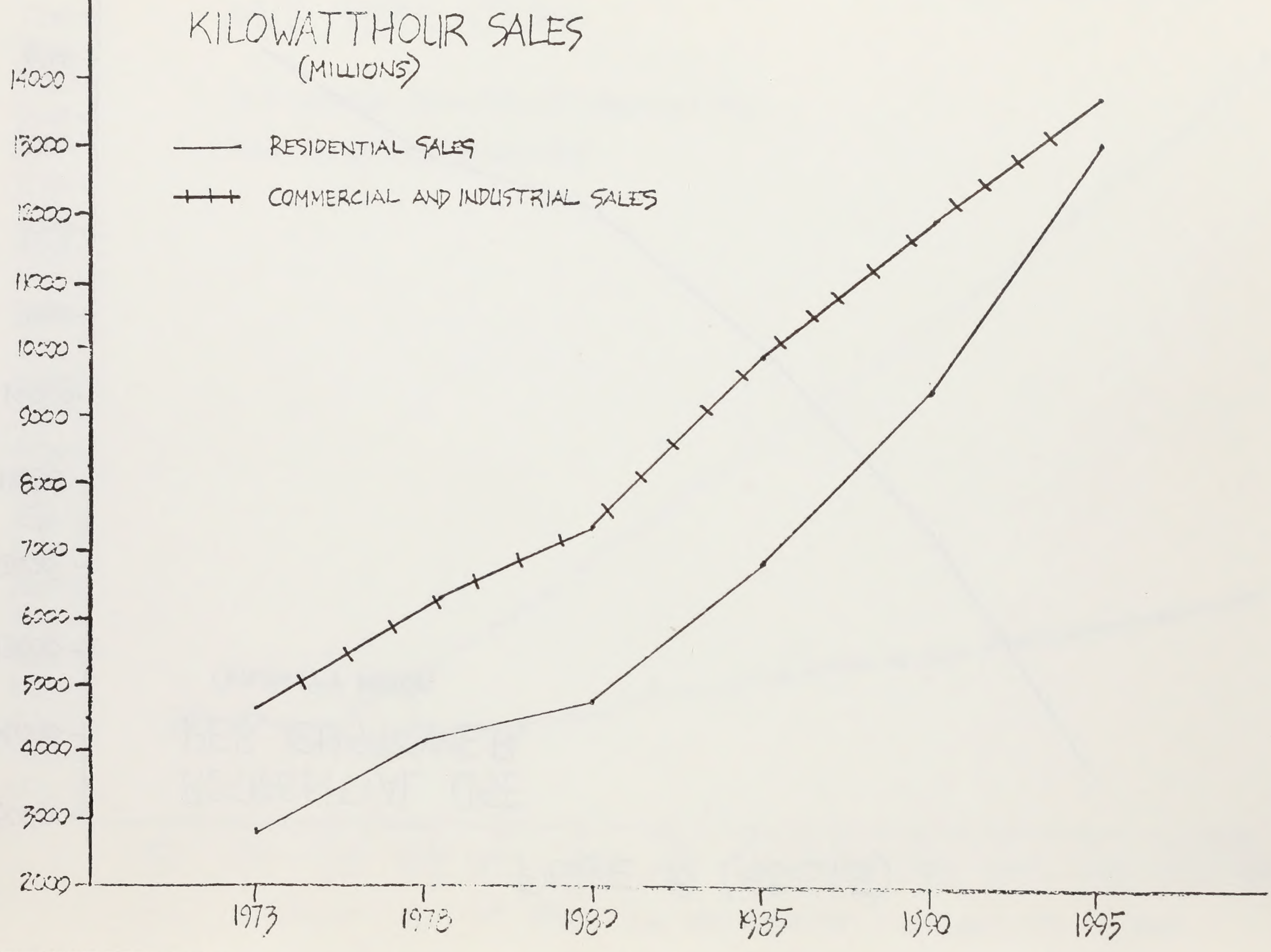


FIGURE 9 (SDG&E)



II. Effects of Providing Electrical Power from Kaiparowits to the Service Area As It Facilitates Urban Growth

OPEN SPACE IN SOUTHERN CALIFORNIA

Open space needs are very much on the minds of Southern California planners and public officials. In the face of estimated current open space deficiencies, the prospect of continued growth, with the resultant loss of land to development, will make the job of providing adequate open space that much harder and more expensive.

> "Open space land is any parcel or area of land or water which is essentially unimproved and devoted to an open space use, and which is designated on a local, regional, or state open space plan for the preservation of natural resources, for the managed production of resources, for outdoor recreation or for public health and safety." (Source: General Plan of Los Angeles County, 1973)

This definition points out the many different uses to which open space may be put. In urban Southern California the preservation of natural resources and the provision of outdoor recreation are the primary goals of an open space plan. The State of California has recognized the importance of open space in and near urban areas. Through the passage of the Open Space Lands Act of 1970 the state found that preservation of open space and avoidance of the premature or unnecessary conversion of open space to urban type development was in the public interest. As one expression of this finding, every city and county in the state must have an open space element in its (required) general plan.

There are three major ways of preserving open space, and they have all been used to varying degrees in Southern California:

1. Acquisition of land
2. Zoning to maintain open space
3. Inducements to keep land in open space

Acquisition

Although the most expensive route, the outright acquisition of land by a public entity is the surest avenue to open space preservation for the long run. Through the power of eminent domain, government can purchase, at a fair price, literally any land that will be used for a valid public purpose. The transfer of land from one governmental entity to another is a further way that local government has aquired open space. This kind of transfer is of particular importance in counties such as San Diego where such large amounts of land are owned by the federal government for military purposes. Camp Pendleton alone encompasses over 380 square miles within San Diego County. The federal government periodically gives or sells land not needed any longer for military purposes to local governments.

Because open space land in or near urban areas is usually very expensive to purchase, local governments have sometimes bought land in anticipation of future urban growth and have thus managed to "save" money. This has happened in several areas in Southern California where the pattern of urban sprawl was obviously leading to future open space needs in certain areas. Growth during the last decade and a half has, however, often outstripped government's ability to stay ahead with the advance purchase of open space land.

Zoning

The reason that zoning is the most common technique used to preserve open space is that it involves no public money. With respect to open space zoning is used in two ways. First, to protect public safety and health certain lands are usually zoned open space because they represent potential flood, earthquake, or slide hazards if developed. Second, some land is zoned open space simply in order to conserve land. Because zoning is traditionally a matter left to each local government, and given the large number of independent governments in Southern California, a wide array of open space policy exists. Some suburban governments plan for little open space within their boundaries because adjoining cities have facilities which are used by residents from the entire area. This creates inequities in taxation within a region. Another problem with the use of zoning as a mainstay of an open space plan is that the pressures to develop land are usually more than can be withstood by the typical city council. The entire history of Southern California sprawl has been written by the continuous granting of zoning variances and zoning changes by local governments to land developers. The conversion of agricultural land (sometimes thought of as real or potential open space) to urban developments has been commonplace throughout the area.

Inducement

The main inducement to keep land in open space in California is the policy of taxing certain privately held agricultural lands at a rate commensurate with its open space designation rather than its potential higher urban value. Through the Land Conservation Act of 1965 (known as the Williamson Act) local governments may enter into contracts (some as long as 25 years) with owners of large amounts of agricultural land. These contracts basically say that the land owner will keep the land in its open space character and in return he will be taxed at the value of open space and not the potential urban value of the land. While it does not address the need for recreational opportunities the Williamson Act has provided the opportunity for Southern California local governments to keep large amounts of land in open space. For instance, by 1972 San Diego County had established agricultural preserves, under the Williamson Act, totaling approximately 120,000 acres.

Recreation

One of the primary uses of open space is for recreational purposes. To give an illustration of the magnitude of the open space issue in Southern California and the impact that continued growth can have in this area some data from the Southern California Association of Governments (SCAG) are presented. The SCAG region consists of the counties of Los Angeles, Ventura, San Bernardino, Riverside, Orange, and Imperial. (See Map in Section I)

SCAG planning documents assume that there are 40 days of outdoor recreation use per person per year. Assuming a current population in Southern California of approximately 10 million then:

10 million X 40 visit days = 400,000,000 visit days per year

If the population of the region were to grow by 2 million in the next twenty five years then:

12 million X 40 visit days = 480,000,000 visit days per year

Therefore, an increase of 20% in population will produce a like 20% increase in recreational use but the size of the increase in recreational use is staggering -- 80,000,000 visit days per year. As this increase in recreational use is occuring, the very fact that the 2 million more people have moved into the region means that there will be less land available to develop as recreational open space. And to show a further problem, these data must be understood in light of the assumption made above that throughout the rest of this century the per capita recreational use will remain constant. Yet the amount of leisure time available to Americans is steadily increasing as the average work-week is reduced in hours. If one assumes an increase in the per capita yearly use of recreational facilities then even the large increase in demand just forecast will be less than reality.

There are advantages and disadvantages to a policy of open space preservation. In Southern California it has been argued that some of the advantages include:

1. Provision of recreational opportunities
2. Provision of pockets of clean air
3. Provision of barriers against noise
4. Improves sense of openness and calm that is often missing from urban life
5. Helps shape the form of urban growth and can be used to prevent costly urban sprawl

From another point of view, an open space policy has been said to have two major disadvantages:

1. Removes land from tax rolls or if Williamson Act is applied it reduces tax revenues.
2. Prevents developers from developing certain lands with resulting possible impact on the local economy, especially the construction industry.

However, the "debate" over open space policy in Southern California is about the amount and location of open space not about the advisability of having open space. This is essentially a political battle where the advice of professional planners is ignored as often as it is followed.

The main point is clear: As population grows there will be an increased demand for open space facilities. There is a good deal of planning activity for open space capital improvement in both the SCAG area and San Diego. (Capital improvement refers to purchase, construction or acquisition on a non-recurring basis of a facility to be used as part of an open space plan.) For instance, in the five years between 1972 and 1977 within the SCAG region, there are 147 cities, 49 special districts, and 6 counties involved in open space planning for over 840 projects. Although it is unlikely that all of these projects will be funded and actually implemented, the sheer magnitude of the effort reveals the intensity with which those in local government in Southern California address the open space issue. As growth continues in the impact area the procurement of adequate open space will be one of the most difficult and controversial issues for local government.

Standards for Open Space

Several attempts have been made to develop criteria or standards by which local communities could judge the adequacy of that part of their open space which is intended for parks and recreation. There is no universally accepted standard, but the following table shows the range of suggested standards for the acres per 1000 people that should be in open space for parks and recreation.

Agency Suggesting Standard	Local Open Space	Regional Open Space
Association of Bay Area Governments (San Francisco)	15	15
National Parks and Recreation Association	20	40
U.S. Bureau of Outdoor Recreation	5	12
Arizona Outdoor Recreation Coordinating Commission	7	18

San Diego County is using as a planning standard the criteria of 15 acres of local open space and 15 acres of regional open space per 1000 people. Los Angeles County has adopted a much more modest criteria: 4 acres for local open space and 6 acres for regional open space per 1000 people. Local open space consists of such things as neighborhood parks, pocket parks, school playgrounds, and neighborhood trails., Regional open space refers to such facilities as lakes, beaches, mountain recreational areas and other such facilities designed to attract people from a radius of one hour's driving time.

Recreational Acreage in the SCAG Region

Table 6 shows the amount of acreage in the six county SCAG region which is in recreational usage. San Diego is not included in the table. One of the conclusions to be derived from examing this table is that local recreational land in urban areas is in substantially less supply than might be called for in the criteria presented above. The table also shows the very large amount of land that is available for recreational use in the regional, coastline, desert, inland water and mountain categories. The vast majority of residents in Southern California must commute considerable distance to enjoy these recreational opportunities. An outdoor oriented recreational life style, coupled with a heavy dependence upon the automobile, means that residents drive very frequently to recreational areas. This in turn contributes to problems of air pollution. Given present trends, increased growth will mean more usage of recreational areas, which in turn will mean more automobile trips.

Table 6

1972 Recreation Resource Areas Inventory (in Acres)*

Types of Area

County	Urban Local	Urban Regional	Coastline	Desert	Inland Water	Mountains
Imperial	178.2	494.1	0	State 34,609 Fed. 637,079	288,520	0
Los Angeles	4,490.1	17,927.9	1,569	Co. 1,547 State 2,875 Fed. 2,500	14,165	Co. 1,310 State 2,053 Fed. 649,045
Orange	2,310.2	2,423.0	953	Fed. 1	1,002	Fed. 51,813
Riverside	1,234.5	5,173.3	0	Co. 21,225 Fed. 2,225,125	61,778	Co. 349 State 1,351 Fed. 258,284
San Bernardino	1,344.5	5,930.0	0	Co. 630 Fed. 6,977,628	9,413	Co. 102 State 9,415 Fed. 427,035
Ventura	647.3	3,700.7	654	Fed. 1,000	8,878	State 6,554 Fed. 2,085
Total Region	10,204.8	35,649.0	3,176	approx.9,904,219	383,756	1,409,396

*Source: Southern California Association of Governments

Open Space in Los Angeles County

Los Angeles County has the largest population in the impact area, and it still contains large potential for growth. Several major conclusions can be drawn from the official plans for open space in Los Angeles County.

The County has found that there currently exists a deficiency of 3450 acres of local parks within the urban areas of the county. Further growth will clearly exacerbate this deficiency. Primarily because of the large number of separate governmental jurisdictions within the county, there is neither a unified policy on open space nor is there any single agency responsible for open space acquisition and management. The absence of a unified approach to the subject leads to duplication of some efforts within the same county and it also creats inequities where some communities rely upon neighboring communities to provide open space opportunities. The County has developed (and SCAG had for the entire six county region) a priority list of areas that should become parks or other recreational areas. Some progress toward implementation of this priority list has been made but there is no question that all currently identified needs will not be fulfilled in the near term future.

Table 7 presents a good summary of the amount and type of currently available outdoor recreational facilities in Los Angeles County as well as a projected 1990 deficiency. These figures are based on what appear to be realistic population growth estimates. The need to acquire an additional 19,931 acres of land within Los Angeles County for outdoor recreation will be very expensive and potentially controversial. Approximately 73% of the projected 1990 deficiency is in local parks (identified in the table as local parks and recreation centers plus school playgrounds). While this local park deficiency currently exists and will continue to exist throughout the county, the most acute need is in the older urban areas, primarily within the City of Los Angeles. These areas tend to be populated

TABLE 7 - SELECTED OUTDOOR RECREATION FACILITIES - 1972

County of Los Angeles

Facility	Primary Respons-ibility	Size	Existing Number	Total Acreage	County Standards	Present Require-ments	Present Deficiency	1990 Require-ments[a]	Defi-ciency to 1990
Local Parks & Recreation Centers	Cities County	1-49 acres	655	7,096	1-1/2 acres/ 1000 persons	10,549 acres	3,453 acres (33%)	11,550 acres	4,454 acres
School Playgrounds[b]	School Districts	Varies	1,454	8,802	2-1/2 acres/ 1000 persons	17,580 acres	8,778 acres (49%)	19,250 acres	10,448 acres
Regional Parks and Botanical Gardens	County Cities	50 acres & over	86	41,171	6 acres/ 1000 persons	42,192 acres	1,021 acres (02.5%)	46,200 acres	5,029 acres
	SUBTOTAL			57,069	10 acres/ 1000 persons	70,321 acres	13,252 acres (19%)	77,000 acres	19,931 acres
Golf Courses	County and Private (if open to Public)	120-160 acres for an 18-hole par 72 course	75 including 16 within regional parks	9,141[c]	One standard 18-hole course for each 90,000 persons	77 18-hole courses	[d] 2 18-hole courses	85 18-hole courses	10 18-hole courses
Beaches	State County, Coastal Cities	Varies	20	1,372	All Available Beach Frontage		Not Applicable		
	GRAND TOTAL:			67,582					

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a - Assuming a population increase to 7.7 million and no change in county standards.

b - Elementary through high school with existing play area, based on State of California standards.

c - Acreage of golf courses outside of regional parks.

d - There are sixteen 18 hole golf courses in Regional Parks and 59 outside Regional Parks.

by racial and ethnic minority groups which have not always been successful in securing an equitable distribution of public services. The potential exists for a serious controversy over open space policy as the county continues to grow outward. This controversy would take place between those residents living in park-poor older areas and those residents living in the newer parts of the sprawl.

Open Space in San Diego County

For further illustrative purposes an examination of some major features of open policy and problems in San Diego County is presented.

Over one-half of the land area in the county (2685 square miles) is in public ownership and most of this is essentially undeveloped. However, most of this land in public ownership is either held by the federal government for military purposes or it is in the mountain and desert area far removed from the urban population, which is located in the western coastal section of the county. There is a need for more open space near or at least easily accessible to the urban population centers. In a similar vein, and with respect to park acreage, San Diego probably does not have a deficiency of park land. However, because this park land is not evenly distributed throughout the urbanized or soon to be urbanized areas, more open space for park land is needed if all citizens are to have access to open space. Table 8 highlights the deficiencies in local recreational open space and at the same time points out the abundance of regional open space.

Some of the most thorough planning for open space in San Diego County has been completed by the San Diego Comprehensive Planning Organization, a group comprised of most cities in the county and the County. The Comprehensive Planning Organization calls for the preservation of 3637 square miles of the county's total 4255 square miles in open space. Almost 75% of this 3637 square miles is already in public ownership, although as has been pointed out most of it is not accessible to the urbanized sector of the population.

Five categories of open space have been proposed in San Diego by the Comprehensive Planning Organization:

1. Existing predominantly open space land in public ownership (2685 square miles)
2. Core open space (732 square miles including water areas) This is land which warrants preservation as open space simply because of the intrinsic qualities of the land.
3. Open Space to shape urban form (157 square miles) This is necessary if the coastal (highly urbanized) sector is not to become an endless sprawl.
4. Transportation corridors (46 square miles) These are bands of open space along or adjacent to freeways and major streets. These corridors will both link core open space areas and also help shape urban growth.
5. Recreation/scenic corridors (17 square miles) These will be located along streambeds, ridgelines, and within canyons and similar areas.

Table 8

San Diego County Local Recreational Open Space Lands
Deficiency For Each City and The Unincorporated Area

	Existing (Acres)	Deficiency 1970 (Acres)	Deficiency 1980 (Acres)	Deficiency 1990 (Acres)
Carlsbad	15.9	-208	-269	-404
Chula Vista	119.0	-900	-1,069	-1,351
Coronado	22.6	-291	-307	-322
Del Mar	-	-60	-75	-105
El Cajon	34.0	-751	-896	-1,075
Escondido	127.4	-425	-593	-773
Imperial Beach	7.7	-295	-337	-412
La Mesa	63.5	-524	-641	-806
National City	114.5	-533	-545	-575
Oceanside	180.6	-427	-629	-824
San Diego	1,546.5	-8,905	-9,583	-10,888
San Marcos	33.0	-26	-42	-72
Vista	47.4	-324	-433	-553
Unincorporated	402.0	-3,987	-4,938	-6,873
County Total	2,714.1	-17,686	-20,386	-25,036

San Diego County Regional Recreational Open Space Lands
Surplus or Deficiency by Major Statistical Area

	Existing (Acres)	Surplus or Deficiency 1970 (Acres)	Surplus or Deficiency 1980 (Acres)	Surplus or Deficiency 1990 (Acres)
Central	1,863	-5,472	-5,832	-6,252
North City	9,133	+4,873	+3,868	+2,143
South Suburban	4,005	+2,055	+1,815	+1,350
East Suburban	5,272	+2,017	+1,657	+1,147
North County	6,562	+3,082	+2,347	+862
East County	1,009,072	+1,008,952	+1,008,922	+1,008,877
County Total	1,035,907	+1,015,507	+1,012,807	+1,008,157

(Source: San Diego Comprehensive Planning Organization, 1973)

POLLUTION

Urban growth is at the heart of Southern California's environmental problems. The desirable natural characteristics of Southern California which have attracted people to the area have been jeopardized by excessive urban growth. The mild and sunny climate has been threatened by a hazy smog which irritates the eyes and lungs; the mountains have been encased in a sheath of smog, and as people have overflowed the coastal lowlands, the mountains have been subjected to excessive development; the ocean and beaches have been the unwilling victims of oil spills; and the delicate ecological balance of the deserts has been threatened by surges of urban dwellers seeking weekend recreation.

Large-scale urban growth puts pressure on both the natural and man-made physical environments. If this pressure is too great, it results in the deterioration of environmental quality. Largely unplanned and unchecked urban growth has put too much pressure on Southern California's environment, resulting in congestion and in esthetic pollution, noise pollution, water pollution, and air pollution. Many miles of Southern California streets traverse through a maze of hamburger stands, gas stations, neon signs, and billboards.

Because excessive urban growth has become urban sprawl, this esthetic pollution has spread amoeba-like and has become especially typical of Southern California. The sprawl has consumed more and more open space, destroying much of the natural environment which formerly provided visual relief from urban blight. With increasing urban growth has come an increasing amount of noise pollution. Motor vehicle exhaust systems and tires, the operation of industrial equipment, and inadequate building insulation have all contributed to noise levels which cause human stress and sometimes even hearing loss. But the most burdensome form of noise pollution has been due to air transportation. Despite some technological advances in noise abatement in the newer aircraft, as urban growth generates more demand for air transportation, the noise level around an airport is multiplied. For example, the number of people in San Diego County subjected to excessive noise levels around airports is expected to increase by almost 80,000 by the year 1995, despite the advent of new, quieter airplanes.

Also with increasing urban growth has come an increase in water pollution. Southern California has escaped some of the water pollution experienced by the rest of the country merely because it does not have as many rivers to use as sewers for industrial and residential wastes. Wastewater, after some treatment, is dumped into the Pacific Ocean. Water pollution in the ocean comes from oil spills and discharges from ships and off-shore drilling platforms. Plans are being made for expanded drilling programs to obtain more oil and with the expansion comes the risk of more oil spills.

But more obvious even than esthetic pollution, noise pollution, and water pollution in Southern California is air pollution. The single greatest source of air pollution is the automobile. The automobile is responsible for more than seventy percent of the smog in the South Coast Air Basin and for as much as eighty-eight percent of the total tons of emissions per day in the basin. (See Figure 10 for an indication of the air basins which cover the Southern California Edison and San Diego Gas and Electric service areas.) Indeed, in Los Angeles county alone motor vehicles emit 12,000 tons of pollutants into the air every day. This amount will increase as the number of vehicles in the area increases. In 1970 there were thirteen million gas-powered vehicles in the state, approximately half of which were registered in the South Coast Air Basin. By 1980 there are expected to be more than sixteen million gas-powered vehicles in the state.

California has not been able to cope with the air pollution produced by the vehicles currently in the state. In 1970, twenty-five years after

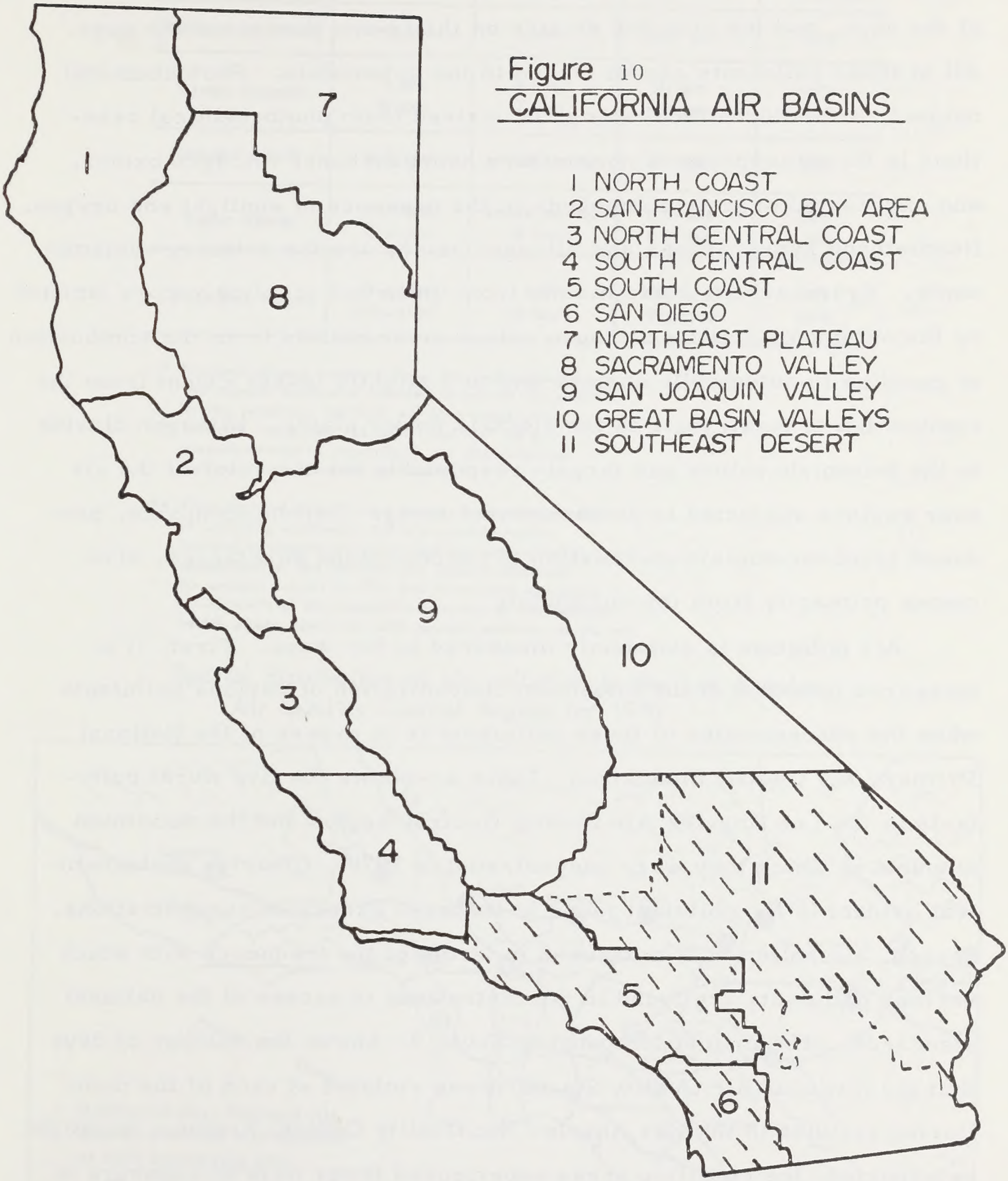


Figure 10
CALIFORNIA AIR BASINS

Dashes indicate impact area.

Source: Environmental Quality Laboratory Report No. 3. (1971)

California enacted its first air pollution control law, Los Angeles County still was unable to meet the standards for photochemical oxidants on sixty-five percent of the days, for carbon monoxide on fifty-five percent of the days, and for nitrogen dioxide on thirty-one percent of the days. All of these pollutants can be traced to the automobile. Photochemical oxidant, or photochemical smog, is derived from photochemical reactions in the atmosphere of nonmethane hydrocarbons, nitrogen oxides, and oxygenated organic compounds in the presence of sunlight and oxygen. Nonmethane hydrocarbons and nitrogen oxides are the primary contaminants. Hydrocarbons come mainly from unburned gasoline vapors emitted by the automobile, while nitrogen oxides come mainly from the combustion of gasoline in automobile engines and to a slightly lesser extent from the combustion of fossil fuels in the electric power plants. Nitrogen dioxide is the brownish-yellow gas largely responsible for the color of the air over regions subjected to photochemical smog. Carbon monoxide, produced from incomplete combustion of carbonaceous substances, also comes primarily from the automobile.

Air pollution is commonly measured in two ways. First, it is measured in terms of the maximum concentration of various pollutants when the concentration of these pollutants is in excess of the National Primary Air Quality Standards. Table 9 shows the five worst pollutants in the Los Angeles Air Quality Control Region and the maximum amounts in which they were concentrated in 1970. Clearly, photochemical oxidant is the pollutant found in the most excessive concentrations. Second, air pollution is measured in terms of the frequency with which various pollutants are found in concentrations in excess of the national standards. The map accompanying Table 9 shows the number of days that the National Air Quality Standard was violated at each of the monitoring stations in the Los Angeles Air Quality Control Region. As might be expected, the coastline areas experienced fewer days of exposure to

Table 9

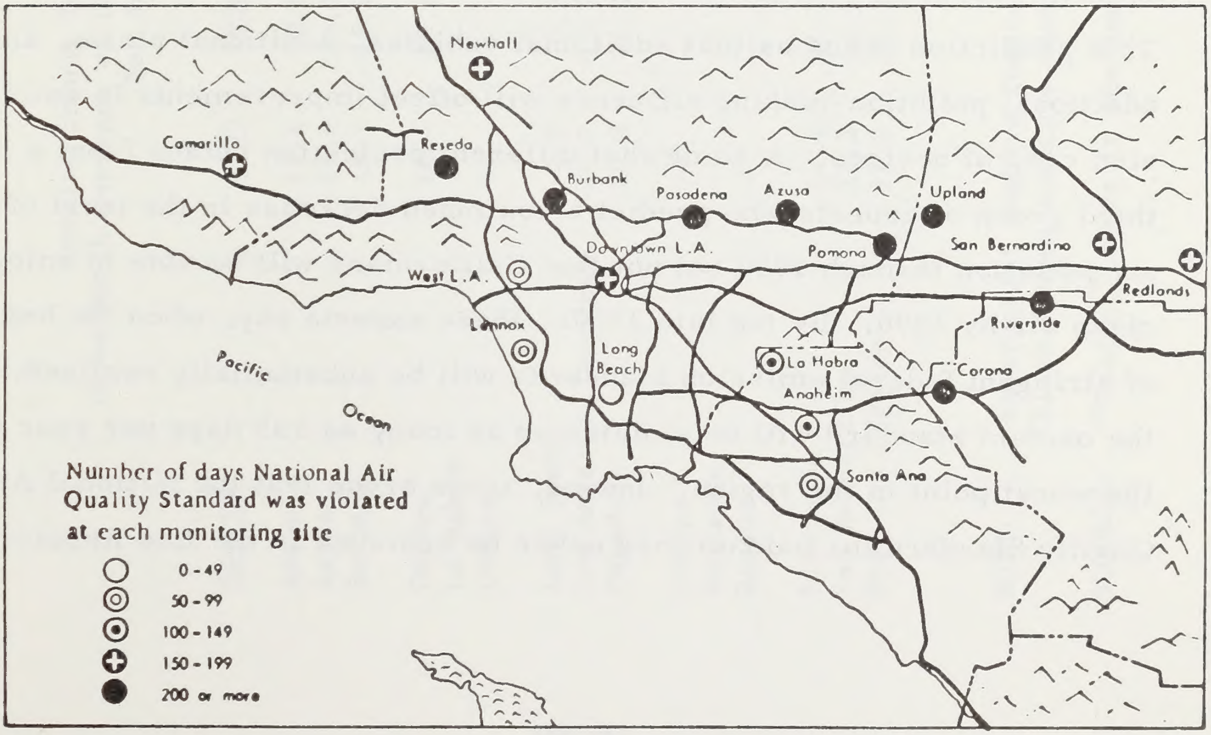
AN OVERVIEW OF AIR POLLUTION IN THE LOS ANGELES AIR QUALITY CONTROL REGION

POLLUTANT	NATIONAL AIR QUALITY STANDARD*		MAXIMUM OBSERVED IN 1970	
	Concentration	Averaging Time	Concentration	% of Standard
Photochemical Oxidant**	0.08 ppm	1 hour	0.62 ppm	780%
Carbon Monoxide	9 ppm 35 ppm	8 hours 1 hour	41 ppm 54 ppm	460% 150%
Nitrogen Dioxide	0.05 ppm	annual average	0.09 ppm	180%
Sulfur Dioxide	0.03 ppm 0.14 ppm	annual average 24 hours	0.03 ppm 0.09 ppm	100% 64%
Particulate Matter	75 $\mu g/m^3$ 260 $\mu g/m^3$	AGM 24 hours	100 $\mu g/m^3$ 399 $\mu g/m^3$	130% 150%

* National primary standard shown for each pollutant. The primary standard is intended to protect the public health; secondary standards are long-range goals intended "to protect the public welfare" (e.g., prevent damage to vegetation). For photochemical oxidant, these standards are identical.

** Photochemical oxidant here denotes a complex mixture of oxidizing substances that are physiologically harmfull to humans and plants and are aesthetically objectionable. The National Air Quality Standard for oxidant was set by EPA and is designed to protect all segments of the population from any of the adverse health effects associated with oxidant pollution of the air.

Spatial distribution of air pollution in the Los Angeles Air Quality Control Region for 1970



Source: Rand Corporation Report R-1524-SCAG, June, 1974.

excessive concentrations of air pollutants than did the areas along the base of the San Gabriel Mountains and in the more heavily populated inland valleys.

Though smog is still a very dominant presence in Southern California, it is not as prevalent as it once was. The concentration of photochemical oxidant in Los Angeles County peaked in 1966 and has been declining since. Table 10 shows the oxidant trends in the South Coast Air Basin from 1963 to 1972. The concentration of oxidant at each of the monitoring sites is circled to indicate the year at which the oxidant level peaked at that site.

Projections of future levels of air pollution in Southern California are in dispute. The current downward trend in the levels of air pollution brought about by automobile emission controls can be expected to continue at least for the remainder of this decade as an increasingly higher percentage of automobiles are equipped with emission control devices. State officials had even predicted that present emission control programs will allow California to enjoy "clean" air (i.e., air which meets existing state air quality standards) by 1990. However, other experts have predicted that the air will start to deteriorate again by 1982 because of the growth in the number of new sources of emissions. This prediction assumes that additional vehicles, additional plants, and additional pollution-making affluence will offset improvements in emission control devices. A somewhat different projection comes from a third group of experts who predict a continued decrease in the level of air pollution through 1990 but not that Californians will be able to enjoy clean air by 1990. By the late 1980s, these experts say, when the benefit of stringent federal emission standards will be substantially realized, the oxidant standard will be violated on as many as 135 days per year at the worst point in the region. Indeed, some argue that the National Air Quality Standard for oxidant may never be achieved in the Los Angeles

TABLE 10

Oxidant Trends in the South Coast Air Basin, 1963-1972
Three-Month Averages of Daily Maximum One-Hour Oxidant Concentrations
For July, August & September
(pphm)

Station	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Anaheim	11.4	9.6	15.9	14.1	12.5	11.9	13.7	10.7	8.9	8.7
Azusa	19.8	24.2	24.4	25.8	26.8	21.9	28.0	28.8	22.9	18.1
Burbank	15.1	15.6	20.9	17.0	22.5	19.0	19.4	18.5	16.1	13.2
Corona	16.4	25.6	16.7	13.8	22.1	16.2	22.0	20.8	13.4	--
La Habra	--	--	15.6	13.3	9.8[a]	11.0	17.2	10.0	15.2	13.3
Lennox	--	--	7.0	7.0	6.7	6.9	6.8	6.2	5.7	3.4
Long Beach	4.2	7.3	6.8	7.8	5.9	4.6	6.3	6.0	6.2	4.0
Los Angeles, Downtown	16.2	15.7	16.2	17.3	13.9	14.3	13.0	13.2	10.0	11.4
Pasadena	20.0	21.9	21.6	22.2	22.6	22.3	27.4	25.7	20.6	17.1
Pomona	--	--	20.8	21.4	23.9	20.8	24.5	23.5	16.6	14.6
Redlands	--	--	--	--	--	17.2	20.4	20.1	17.1	13.8
Reseda	--	--	18.6	19.6	20.9	18.0	20.1	17.4	14.2	12.1
Riverside	17.4	21.2	16.6	18.6	25.2	19.5	25.6	25.6	22.9	22.2
San Bernardino	15.5	12.2	17.0	17.0	18.2	15.2	18.9	23.1	18.7	14.8
West Los Angeles	11.9	10.3	11.3	11.6	11.1	11.2	11.0	10.1	8.4	7.1

NOTE: Superscript numbers indicate number of months of missing data.
Blank spaces indicate stations were not operating.

SCOURCE: "Oxidant Trends in the South Coast Air Basin, 1963-1972," California Air Resources Board.

Air Quality Control Region, even with major reductions in the number of vehicle miles travelled, because of emissions from additional automobiles, trucks, aircraft, and stationary sources.

Out of these different predictions emerges one clear point: the South Coast Air Basin will be subjected to continuing smog. The greater the amount of growth, and the more it takes the form of automobile dependent sprawl, the worse the air pollution.

TRANSPORTATION

The history of transportation in the impact area has been the history of the automobile. Motor vehicles have served as the primary means for moving people and goods throughout this region. The primacy of the motor vehicle is well illustrated by the following table:

Motor Vehicle Registration

County	1961	1973	Percent Increase
Los Angeles	3,404,147	4,918,510	45
Orange	419,552	1,220,697	191
Ventura	112,447	300,132	167
Riverside	180,977	401,864	122
San Bernardino	281,529	522,777	86
San Diego	520,983	1,604,461	208
Total	4,919,635	8,968,441	82

The number of motor vehicles in the six county impact area has almost doubled in the last twelve years. However, the motor vehicle increase for some counties has been much greater. According to the Department of Motor Vehicles a somewhat more subdued rate of increase in motor vehicle registration can be expected -- around 4.5% per annum -- but one which will nevertheless be greater than that predicted for population. The reliance on motor vehicles for transportation is further substantiated by the fact that 73% of all registered vehicles in California are located in the six county impact area.

To accomodate the vast number of motor vehicles making daily trips in the area, California has developed an extensive system of freeways, roads and streets. There is now well over one thousand miles of freeways located within the impact area. Future freeway construction is expected to at least double, perhaps triple, this number. The following table shows the extent of freeway construction in the impact area:

Existing and Planned Freeway Construction
(Miles)

County	Freeways and Expressways in Operation	Total Planned System	Percent Increase
Los Angeles	414.5	1,042.1	151
Orange	127.7	247.6	94
Ventura	77.3	253.9	228
Riverside	188.2	392.0	108
San Bernardino	386.8	971.0	151
San Diego	195.0	300.0	54
Total	1,371.5	3,206.6	134

Motor vehicles are expected to continue to provide the major mode of transportation in the impact area.

But reliance on motor vehicles to provide for the transportation needs of Southern Californians has meant severe hardships for many segments of society, particularly the poor, handicapped and elderly who, for various reasons, do not have access to an automobile. For them, the vast freeway system and the vast number of automobiles which travel on it have not enhanced their lives. Instead, they must rely on public buses to move from place to place. Yet it has only been within the last 15-20 years that any concerted effort has been made to upgrade public transportation. The history of public transportation in Los Angeles provides a good illustration. Origionally public transportation was provided by private companies, the Pacific Electric Railway and the Los Angeles Railway Company. Increasing competition by motor coach operators eventually led to a decline in rail services. It was not until 1951 that the California legislature created the Los Angeles Metropolitan Transit Authority (later changed to the Southern California Rapid Transit District (SCRTD)), and it was not until 1957 that the MTA was empowered to acquire and consolidate privately owned systems and construct a rapid transit system. To date, buses have been the sole ingredient of the rapid transit system because voters have so far failed to approve any revenue plan for an expanded system. SCRTD plans to submit a new revenue plan for rapid transit to the voters on the November 1974 ballot. If approved SCRTD will implement its mass transit plan. Passage of the bond issue is highly problematical.

Transportation in the SCE Impact Area

A. Mass Transit

SCRTD has developed an extensive plan for public mass transit in the greater Los Angeles area. According to the SCRTD proposal, mass transit will take two forms: a near-term expansion of existing transit services and a longer range construction of a fixed guideway system similar to that already in service in the San Francisco Bay Area. The major components of the near term expansion plan are:

1. increasing the number of vehicles from 1700 to 2700 by 1977.
2. construction of park and ride facilities.
3. new express-on-freeway services to serve park and ride passengers.
4. development of new bus only lanes on freeways.
5. introduction of limited commuter rail service.

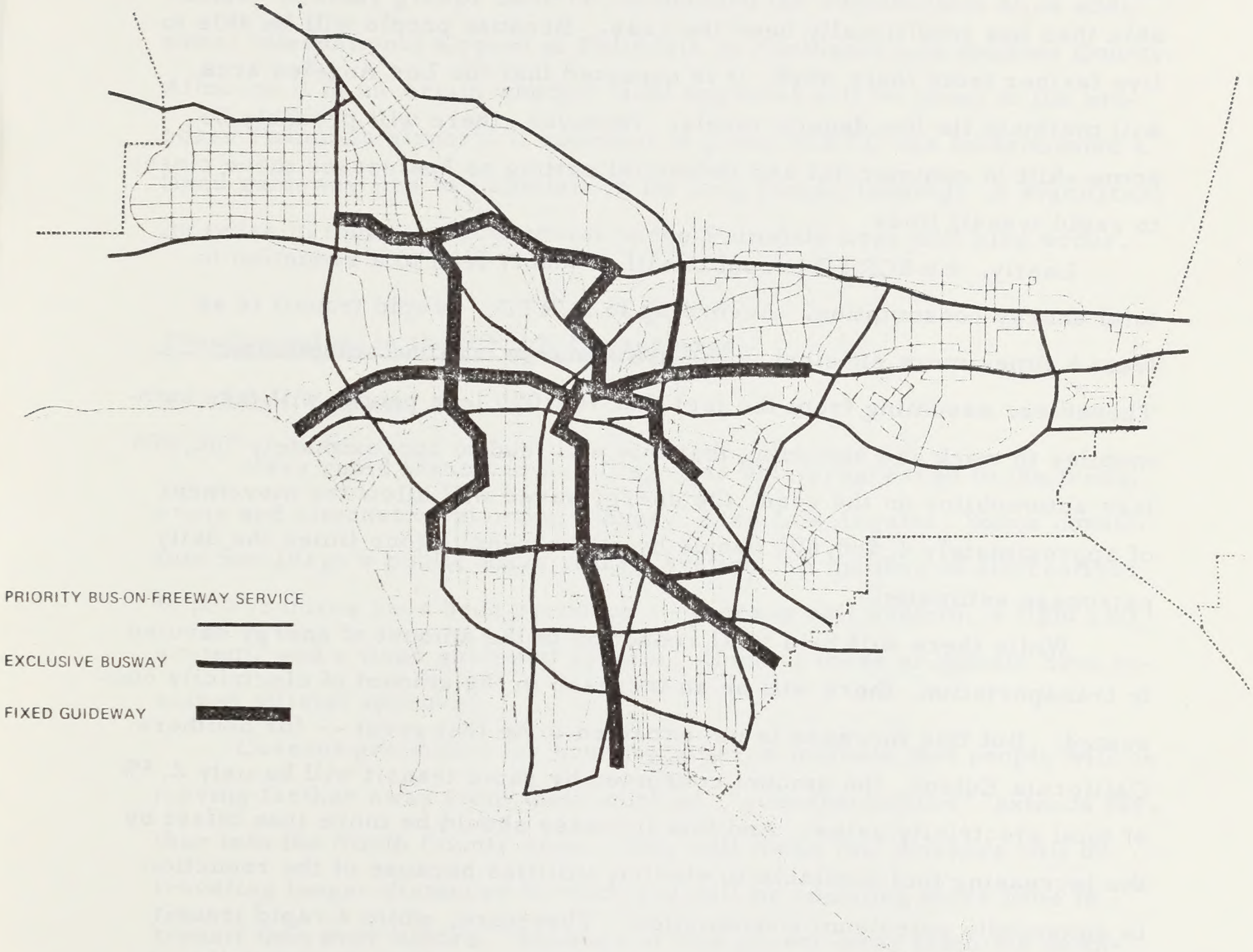
These measures are designed to attract a greater number of passengers by (1) making bus travel more convenient, (2) expanding the frequency of bus service, and (3) expanding the area served by bus service. Under the proposal, passengers will be able to drive to centrally located terminals and ride a bus to work. By attracting commuters in outlying areas, it is hoped that reductions in air pollution and freeway congestion can be achieved. In addition, by reducing the number of automobiles which drive to the downtown business district, there will be a reduction in the construction of new parking facilities. At the present time, 30% of the total area in downtown Los Angeles is devoted to parking lots. This is in addition to the 30% used for streets.

The long range SCRTD plans center around the construction of a 121 mile fixed guideway system. This guideway system would service the most heavily populated areas of Los Angeles (see Figure 11), and is the most costly component of the SCRTD proposal. It is estimated that the total costs of the near-term expansion program will run approximately 198 million dollars (through 1977) whereas the total costs for the fixed guideway system are projected to be approximately 6.6 billion dollars. Two thirds of the capital outlay is expected to come from the Federal Government.

A fixed guideway system for the Los Angeles area becomes especially expensive because of the large territory involved. It is asserted that a fixed guideway system, because it runs on electricity, will significantly reduce air pollution in the South Coast Air Basin and particularly in the downtown area. This claim has recently been challenged by some experts who argue that increased emission controls on both motor vehicles and stationary sources of pollution will reduce the volume of air pollutants to acceptable levels regardless of whether a fixed guideway system is constructed.

However, the impact of an integrated mass transit system in the Los Angeles area will be significant. Because such a system will facilitate the movement of people over broad areas of the county, it is expected that reliance on the automobile will decrease. SCRTD estimates that by 1990, some 1,050,000 persons will make daily rapid transit trips. Of this total, 706,000 will be people who would otherwise use automobiles. The most significant reduction in automobile travel will be in the downtown areas.

FIGURE 11



Source: Southern California Rapid Transit District

Currently, about 35% of the work trips made to the central business districts are by public transportation. By 1990 it is estimated that this figure will jump to 65%.

A mass transit system will also open up new employment opportunities because people will be able to travel farther to work (or to find work) thereby making more employment centers accessible and affordable than has traditionally been the case. Because people will be able to live farther from their work, it is expected that the Los Angeles area will maintain its low density levels. However, there will probably be some shift in commercial and industrial setting as businesses move closer to rapid transit lines.

Lastly, the SCRTD proposal will probably lead to a reduction in total energy consumption. According to SCRTD, "rapid transit is at least 6 times more efficient in the use of energy than the automobile." Therefore, assuming from the fact that 706,000 less people will take automobiles to work and assuming that this will lead to approximately 500,000 less automobiles on the road, the energy saved will allow the movement of approximately 4,500,000 people by rapid transit, four times the daily patronage estimated.

While there will be a total reduction in the amount of energy devoted to transportation, there will be an increase in the amount of electricity consumed. But this increase is not expected to be that great -- for Southern California Edison, the amount consumed by rapid transit will be only 2.5% of total electricity sales. And this increase should be more than offset by the increasing fuel available to electric utilities because of the reduction in automobile petroleum consumption. Therefore, while a rapid transit system is expected to lead to an increased consumption of electricity, it is also expected to lead to an even larger supply of electricity generating fuel supplies.

B. Other Transportation Areas

There is currently only one major airport in the six county impact area -- Los Angeles International Airport (LAX). There are also a number of intermediate airports (Long Beach, Burbank, and Ontario) which primarily service intra-state flights. Throughout the past few years, a number of study groups have recommended the construction of an additional international airport at Palmdale in Northeast Los Angeles County. Although it is uncertain whether final approval will be given to the proposed Palmdale airport, if approval is given SCRTD has incorporated a fixed guideway line to Palmdale in its long range planning. A significant increase in motor vehicle travel to the Palmdale area will also occur.

Transportation in the SDG&E Impact Area

A. Mass Transit

Mass rapid transit in San Diego has only progressed to the initial study and alternative planning stages. Like Los Angeles, buses constitute San Diego's public mass transit system. A number of alternatives to public buses have been proposed - - a heavy rail system, a light rail system, and a fixed guideway system. None of these proposals have received official approval.

Current projection for housing patterns indicate that people will be moving farther away from their work as "suburbanization" extends farther into the North County area. This will mean that workers will be traveling longer distances to work and will be spending more time in transit than ever before. Because of this growth away from the downtown areas, any mass transit system will necessarily have to service a large area.

It is estimated that a rapid transit system would attract about 800,000 passengers annually, capturing around 10% of all trips made in the region. With respect to home-to-work trips, the rapid transit system would provide service for about 16% of these trips and around 50% of the home-to-work trips destined for the downtown areas.

Because the future of rapid transit is so tenuous, it is impossible to say with any accuracy when, if at all, construction will begin and what kind of system will finally be approved. For the present, expanding existing bus services will be the primary means for upgrading the mass transit system.

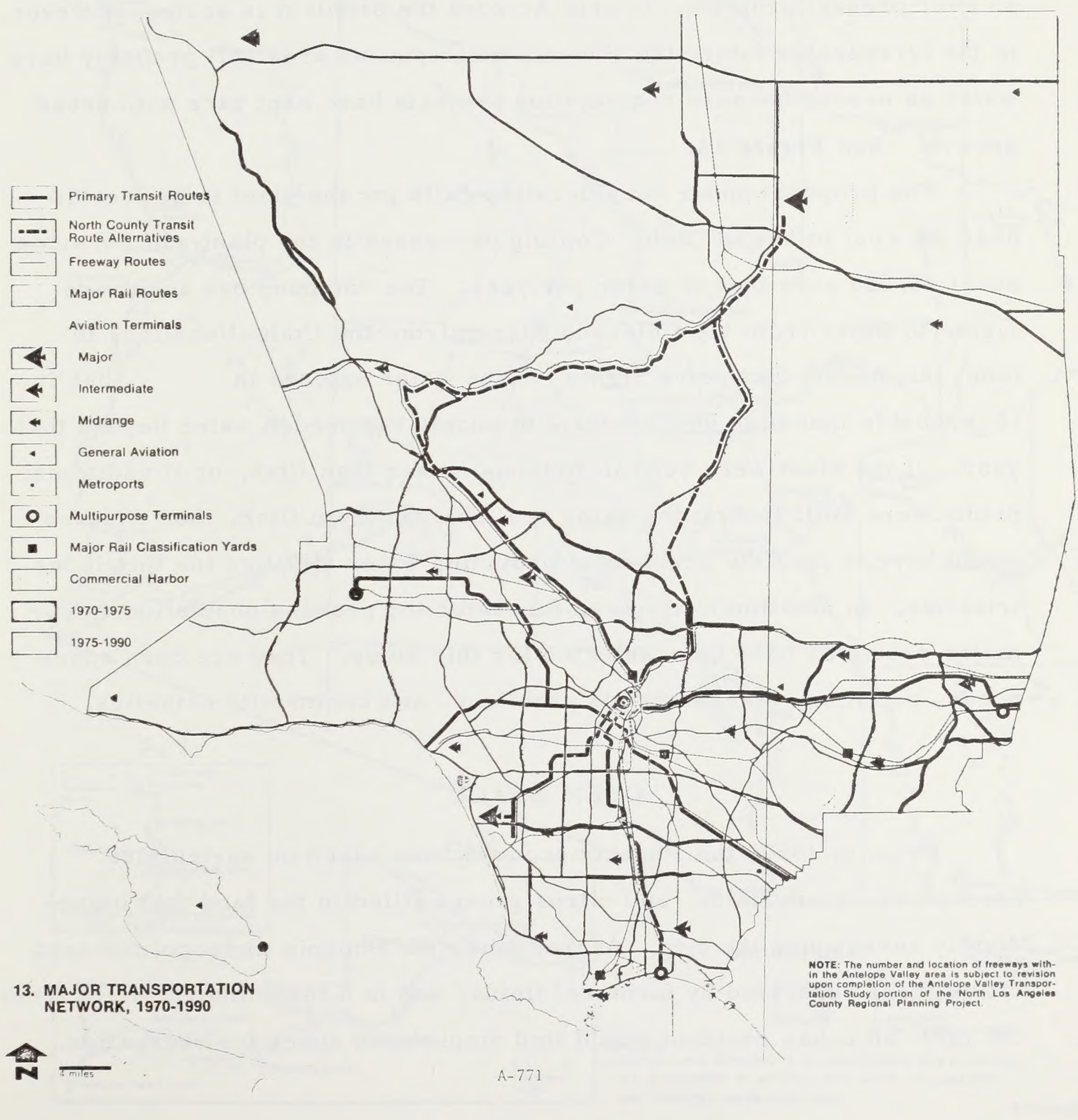
B. Other Areas

There are three airports in San Diego County, two of which are operated by the Navy. The municipal airport, Lindberg Field is an international airport. There are no official plans for building an additional airport.

In December, 1972, the California Legislature passed the "Mills Act" which authorizes $30,000 per month for use by cities and counties for constructing bicycle lanes. San Diego county has received top priority in the use of these funds, receiving some $6,000. Because of the prohibitive costs of constructing separate bicycle paths, San Diego plans to provide special lanes for bicycles on existing roadways.

FIGURE 12

Major Transportation Network, Los Angeles County



13. MAJOR TRANSPORTATION NETWORK, 1970-1990

NOTE: The number and location of freeways within the Antelope Valley area is subject to revision upon completion of the Antelope Valley Transportation Study portion of the North Los Angeles County Regional Planning Project.

EFFECT ON ARIZONA

The amount of power which the Arizona companies will receive from Kaiparowits does not represent a large portion of their total supply. However, the aquiring of power as needed does facilitate urban growth and Arizona population centers experience problems generally associated with urbanization and some problems that are somewhat unique to Arizona.

In all the Western states, the aquiring of needed water supplies is an ever present problem; in arid Arizona the problem is acute. However, in the foreseeable future the Phoenix metropolitan area will probably have water as needed because reclamation projects have kept pace with urban growth. See Figure 13.

The proposal under consideration calls for the plant to be located near the coal mines in Utah. Cooling processes in the plant will consume about 45,000 acre feet of water per year. The company has acquired rights to water from the Colorado River, from the Utah allocation, to meet this need. Exclusive rights for the water expires in   but it is probable that Utah will continue to supply the needed water beyond that year. If the plant were built in Arizona rather than Utah, or if additional plants were built in Arizona using coal shipped from Utah, then Arizona would have to face the problem of providing water supplies for this industrial use. In addition to the need for water for growing populations, four major problems have been selected for this study. They are open space needs, pollution, transportation problems, and community esthetics.

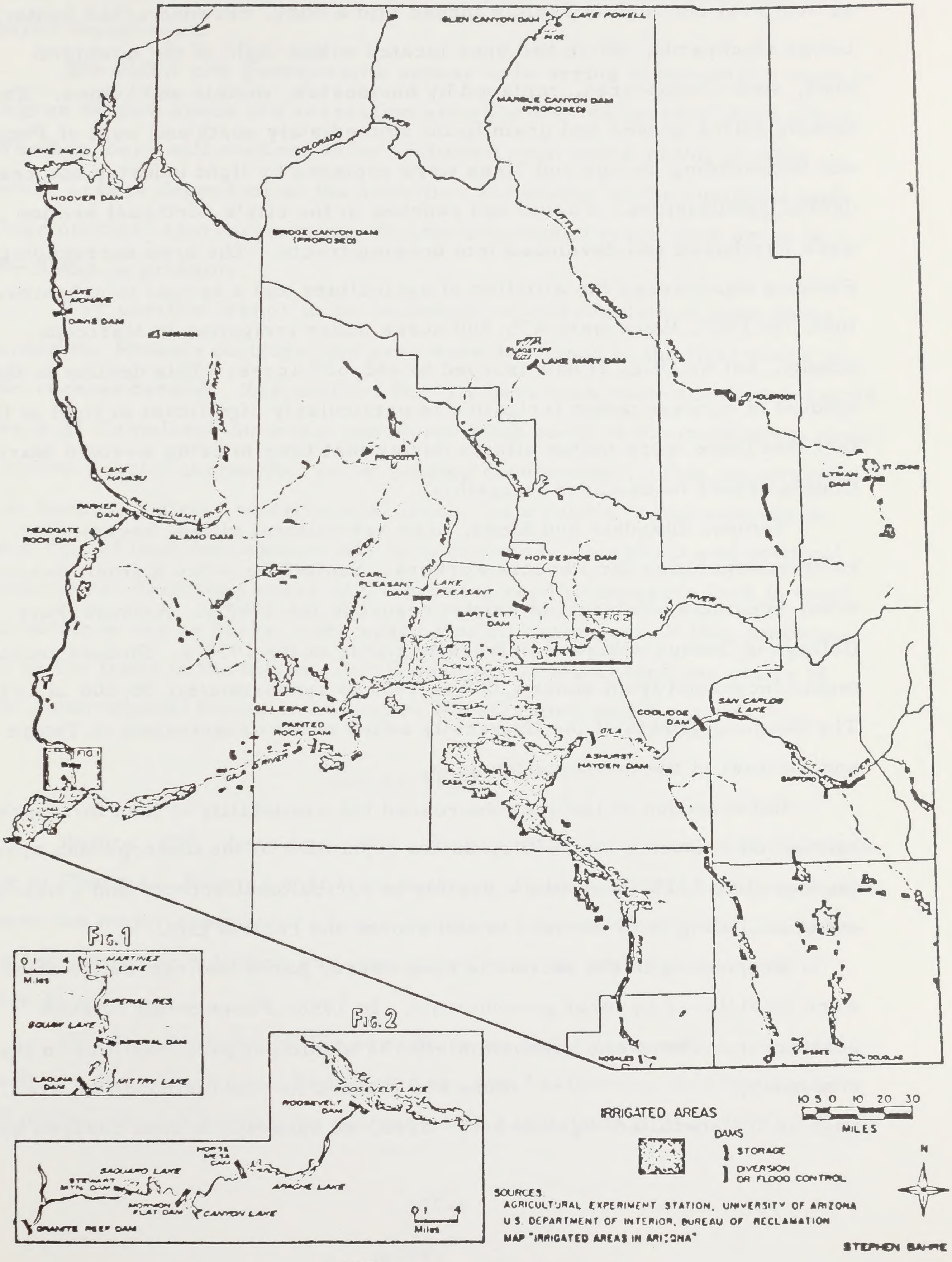
OPEN SPACE

Prior to 1950, the Phoenix economy was based on agriculture. Stockyards, grain fields, and citrus groves filled in the land that immediately surrounded the city. At that time, the Phoenix metropolitan area cities were separated by farmers' fields, and in a few minutes' drive from the city, an urban resident would find ample open space for recreation.

FIGURE 13

MAJOR DAMS AND IRRIGATED AREAS

- 1966 -



SOURCES:
AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF ARIZONA
U.S. DEPARTMENT OF INTERIOR, BUREAU OF RECLAMATION
MAP "IRRIGATED AREAS IN ARIZONA"

STEPHEN BAHRE

During the 1950's, however, the area in and around Phoenix experienced phenomenal industrial, commercial and residential growth. This agricultural community rapidly turned into a busy, crowded urban center. Large stockyards, which had been located within sight of the downtown area, soon disappeared, replaced by businesses, motels and homes. Extensive citrus groves and grain fields immediately north and west of Phoenix and surrounding Tempe and Mesa were replaced by light industry and residential subdivisions. Farms and ranches in the city's northeast section were purchased and developed into housing tracts. The area surrounding Phoenix experienced the attrition of agriculture and a spread in urbanization. In 1949, there were 475,000 acres under irrigation in Maricopa County, but by 1972, it had dropped to 442,600 acres. This decline in the amount of acreage under irrigation is particularly significant in light of the fact that there were major efforts during that time to bring western Maricopa County desert lands under irrigation.

Tempe, Glendale and Mesa, once agricultural cities, became bedroom communities for Phoenix workers. Scottsdale, once a small desert town, became a westernized tourist resort in the 1960's. Arizona State College in Tempe achieved University status in the 1950's. Student enrollments increased from about 6,000 in 1950 to approximately 30,000 in 1973. The booming growth of the University added to the urbanization of Tempe and the rest of the metropolitan area.

Urbanization of the area decreased the availability of land for recreational use. During the 1950's, as the population of the metropolitan area increased by 311% there was a decline in agricultural activity and a nearly complete filling in of the land in and around the central city.

Responding to the decline in open space, parks and recreation sites were established by local governments. In 1956, Phoenix had 35 such park areas. There are approximately 133 municipal park facilities in the city today. More are planned for the metropolitan area, such as the so-called "green-belt" area, an open-space area covered by natural desert vegetation supposed to stretch east to west through the SMSA. Neighborhood parks are established when new housing tracts are constructed, but these parks are generally poorly maintained by the city parks department.

The SMSA city governments appear to be trying to maintain a certain degree of open space and recreation sites for the residents of their cities. Whether there will continue to be additional open space in the growing urban area is dependent on the activities and wishes of the residents and their political representatives. But the creation of more park areas in the SMSA is probable.

Two positive trends in the maintenance and creation of open space within the Phoenix metropolitan area have developed in the first years of the current decade. Residents of the city have seen once-scenic landmarks (such as Camelback Mountain and Squaw Peak north of the main urban area) become heavily encroached on by housing development. This construction has become a highly controversial issue; as a result, a moratorium on this type of land development has been declared. Residents and political leaders are becoming aware of the growing need to preserve land in local mountain areas as parks, open space that all can enjoy. If this continues to be the trend in the future, it will doubtlessly affect land use policy of the governmental bodies in the entire Phoenix metropolitan area.

POLLUTION

Before 1950, there was little pollution of the environment in the vicinity of Phoenix. Blowing dust from farmers' fields and odor from stockyards were the major contributors to air pollution. Because industrial, residential or vehicular pollution was considered to be no problem, records of this do not exist.

The decade of the 1950's brought to the SMSA tremendous growth in industry and commerce. New factories, new businesses, and thousands of motor vehicles brought an increase in air pollutants to the SMSA. This is illustrated by the following statistics: in 1951, there were 152,121 motor vehicles registered in Maricopa County; by 1970, a total of 726,709 vehicles were registered in the county, an increase of 378% over the nineteen year period.

By the mid-1960's, urbanization had effectively removed much of the oxygen-producing vegetation from the area. Black Canyon freeway through Phoenix was built in the late 1950's, replacing older city, county and state roads that had had a limiting affect on travel. Major cross-town streets were widened and improved to permit greater use. Sky Harbor International Airport was built about 1960 facilitating air travel and related pollution.

The increase in air travel in the Phoenix area, the decrease in bus travel within the metropolitan area and the concomitant rise in vehicular travel had all added to the rise in pollution of the surrounding environment. Airline exhaust accounts for the second-highest source of transportation-related pollution in the Phoenix metropolitan area, after automotive pollutants. This has increased the air and noise pollution levels in the area. The increased availability of effective commercial, domestic and vehicular air conditioning units enhanced the reputation of Phoenix as a year-round residence. What had once been a haven for farmers and people convalescing from respiratory ailments became, by the late 1950's, a booming center of industry, commerce and population. In the mid-1960's, air pollution became a serious issue.

The Maricopa County Department of Health Services, Bureau of Air Pollution was created by statute in 1964, as part of a continuing effort to control pollution of the air in the county. The largest part of the air pollution problem is located in the Phoenix SMSA. This is also where most of the effort at control is located. In the fiscal year 1949-50, 91.3 million gallons of motor fuel were consumed in Maricopa County. By 1970, 479.9 million gallons of motor fuel were consumed in the county. Approximately 75% to 80% of this was used in the Phoenix SMSA causing a concentration of air pollution in that area.

One trend found by the Bureau of Air Pollution was that the maximum levels of gaseous pollutants are reached in the winter months of November through February when air stagnation conditions are most prevalent. Table 11 shows trends for concentration of gaseous pollutants from 1967 to 1973. The figures for air quality in the suburban cities of the SMSA would reflect lower levels of gaseous pollutants. This is a result of their location away from the heavily industrial inner city.

Increased tourism, the building of adult retirement communities around the SMSA, the increasing development of freeways in the area, the multiplication of electronics manufacturing plants, and expanded air travel will probably increase the problem of environmental pollution in Phoenix. Demands will be placed on the services of local government bodies to solve the increasing pollution, and it seems that the Bureau of Air Pollution will be the agency most heavily involved in future efforts at problem solving. They have had some success in controlling pollution levels since 1967; this may not continue in the future if urban growth accelerates.

Concurrent with the deterioration in air quality has been the problem of increasing the supply of water and sewage treatment facilities. Central Arizona Project is constantly striving to meet the water demands of the Phoenix area residents, and to date the Project has been most successful. Sewage treatment facilities have been expanded to meet the increasing supply of raw sewage. Local city water departments are coping with the problem by planning and constructing more such facilities as the need arises.

Since the Phoenix SMSA and western Arizona are a desert region, there are very few natural or man-made bodies of water to be affected by pollution. Those that do exist, such as the system of reservoirs northeast of Phoenix are used for recreational purposes as well as for human consumption, irrigation, and industry in the metropolitan area. After being treated in area sewage plants, waste water is discharged into the now dry Salt River so no effluent mixes with the nearby fresh water supply. Much of the water for western Arizona comes from the Colorado River or from deep water wells near towns and cities. These sources have remained nearly free of man-caused pollution in the past; they should remain so in future years, provided that increased urbanization along the Colorado River is planned in such a way as to develop sufficient water/sewage treatment facilities.

Noise pollution is another consequence of the urbanization of the Phoenix SMSA. Prior to 1950 the metropolitan area was an agricultural area; what noise did occur was negligible. The lack of statistical information reflects this fact. Concern about noise pollution (decibel levels) resulted in several studies during the early 1970's. Noise monitors indicated freeway, airport, and major street intersections were problem areas. Attempts to decrease this have been made by the installation of various kinds of devices at the airport and on the freeway. The effectiveness of these is under investigation.

TRANSPORTATION

The only major routes for vehicular travel to and from Phoenix in 1950 were two-lane highways that entered Phoenix from the southwest, northwest, southeast and east. In the urban area, no freeway system had yet been constructed. All traffic within the city was routed on the existing city streets.

The first change in this situation came in the late 1950's with the construction of the Black Canyon freeway through the western area of urban Phoenix. As the metropolitan area grew, so did the need for improved mass transportation facilities in and through the SMSA. Two major interstate freeways connect Phoenix with other points in Arizona at the present time. Interstate 10 is still incomplete. Plans for construction were halted in 1973 following court action and legislative referenda initiated by citizen groups concerned with air, noise, and esthetic pollution.

Since 1887, public transportation services have existed in the downtown Phoenix area. Horse-drawn cars were replaced by electrically operated streetcars. In 1948, the city sold its streetcars converting all services to motor vehicle (bus) operations. In 1959, the city bus system was sold to a private group which operated it as part of the Valley Transit Lines. In 1966, this bus company was sold to the Phoenix Transit Corporation.

Residential preferences for private cars, service cuts and fare increases have produced a decline in public transportation patronage in the metropolitan area. Table 11 shows the yearly decrease in persons utilizing the bus system as a method of transportation in the Phoenix SMSA. Traffic congestion, inadequate parking facilities and air pollution problems have generated discussion and studies to relieve the situation, but no major decisions have been made. Continental Trailways and Greyhound Bus Lines serve the area with intra-state and interstate bus travel, as well as offering intra-metropolitan service to Phoenix area residents, but they do not compete with the automobile as the prefered mode of travel.

In the late 1950's construction began to enlarge and expand airline facilities at the Phoenix municipal airport. Commercial jet service started in 1958. In 1970 the Phoenix airport (Sky Harbor) became an international arrival and departure facility. Table 11 shows that growth in terms of total passengers enplaned and deplaned. At the present time seven major commercial airlines provide passenger service. The Sky Harbor facilities are also used by private, commercial freight, and military aricraft.

About 9 other airports exist in the SMSA. Two of these, Luke and Williams, are Air Force Bases. The other seven are primarily for private aircraft use. Traffic at each has increased as aircraft use has become more popular in the past several years.

Passenger service provided by the Southern Pacific railroad was started in the Phoenix area in the late nineteenth century. That service grew over the years, with the addition of lines to northern Arizona and the Grand Canyon. By the 1950's, however, travel by automobile and airplane had caused a decrease in the number of passengers on the railroad. Today, with the Amtrack Corporation assuming railroad operations in the area, there seems to be revitalized interest in the railroad as a means of personal transportation. If Amtrack continues to increase the quantity and quality of passenger services, future years will probably see the railroad become a popular method of passenger travel once more.

Because of its tremendous rate of growth in the past twenty-four years, Phoenix and its surrounding cities have shared a number of problems: pollution, lack of open space for recreation, and poor transportation. Work has been continuing since the late 1950's on most of these problems; some success has occured, some failure has slowed down ultimate solutions. Since the metropolis is projected to continue growing at a high rate, the problems will not disappear. Unless residents and civic leaders cooperate in finding solutions, Phoenix will face problems parallel to those of larger metropolitan areas.

COMMUNITY ESTHETICS

Within the Phoenix area community esthetics vary greatly. In some areas attention is given to conservation of indeginous vegetation, control of outside advertising, and archeticural design standards. In other areas standards are non-existent. Although the esthetic standards are in part the result of local initiative, there is a double standard which discriminates. Some businessmen participate in activities in neighborhoods which deteriorates the community esthetics in ways they would not tolerate in their own neighborhood. The sharp distinction between the quality of different neighborhoods helps cause increased pollution and transportation problems because it encourages greater suburbanization. Those who work in Phoenix may have to commute long distances to find quality areas in which to live.

The Phoenix area is experiencing a pattern of growth similar to that of Los Angeles. Build up in the central city area is accompanied by urban sprawl and suburbanization with high reliance on the automobile. A lack of an aggressive mass transportation policy encourages even greater dependence on automobile transporation and an over-abundance of automobiles will determine the nature of land-use.

Yuma and Flagstaff are not major urban centers, but they are experiencing problems that accompany growth. There is a general deterioration of the environment in and around the communities. In Yuma the local planning department is aware of problems related to maintaining and improving the esthetic qualities of the city.

Flagstaff, being located in a pine forest, has a unique opportunity to use the indeginous vegetation to enhance community esthetics. However, the city is following an established pattern of clearing out complete areas of the forest for commercial development and is not near as attractive as a few protective measures could insure.

Several desirable facilities, such as mass transportation, are inadequate or lacking, in the utility service area outside of Phoenix. However, except for the Phoenix area, pollution problems are not widespread yet.

TABLE 11

PHOENIX GROWTH STATISTICS - 1973

	1956-57	1960-61	1970-71	Estimated 1972-73	Estimated 1973-74
AREA (Square Miles)	36.3	191.1	254.9	269.3	269.3
POPULATION (Estimated June 30)	172,569	451,964	620,750	723,700	771,800
AUTHORIZED EMPLOYEES					
(Per 1,000 Population)					
Governmental	9.1	7.2	7.9	8.4	8.5
Public Enterprise	1.4	0.9	1.1	1.1	1.1
POLICE					
Police Employees	264	618	1,273	1,523	1,632
Major Crimes (Crime Index Offenses)**	3,560	10,498	31,075	36,600	43,150
Traffic Accidents	6,600	13,500	22,765	29,700	34,100
FIRE					
Fire Stations	12	21	30	30	31
Calls for Service	2,400	6,400	14,347	15,485	20,000
BUILDING INSPECTIONS					
Total Permits Issued ($000)	32,087	87,500	268,585	400,000	400,000
Total Number of Inspections***	75,336	195,205	236,000	319,000	359,000
TRAFFIC CONTROL AND LIGHTING					
Signalized Intersections	146	285	423	440	458
Street Lights in Use	7,800	15,600	23,097	25,000	25,800
Miles of Major Streets Lighted	64	134	155	172	216
STREETS					
Total Miles	756	1,496	2,270	2,424	2,545
Miles Cleaned	45,000	110,000	165,880	174,000	174,000
Miles Resurfaced and Sealed by Contract	26.0	42.0	378.0****	354.1****	224.2****
REFUSE COLLECTION					
Residences Served	50,000	141,000	204,800	243,000	258,000
Refuse Collected (Tons)	87,460	200,435	325,300	420,000	470,000
SANITARY SEWERS					
Connections	35,000	90,000	169,255	203,000	215,000
Miles of Lines	444	965	2,090	2,370	2,520
LIBRARIES					
Book Circulation	648,505	1,221,412	2,368,232	2,410,877	2,601,382
Total Bookstock	191,884	243,904	704,940	790,985	903,772
MUNICIPAL PARKS					
Park Areas	35	48	121	129	133
WATER					
Connections	60,650	122,073	172,100	210,000	225,000
Production (Billions of Gallons)	16.7	33.8	52.7	60.7	64.1
AVIATION					
Passengers Enplaned and Deplaned	535,000	864,000	2,925,700	3,752,000	4,127,000
VEHICLES IN SERVICE					
Total Vehicles in Service	739	1,434	2,673	3,146	3,369

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*Full Time Equivalent Positions, Excluding PEP Employees

**1972 FBI Crime Reporting Format

***Building, Electrical, Mechanical, Plumbing

****Local Street Equivalents

Gaseous Pollutants,1973

(Continuation of Table 11)

SAMPLER	LOCATION	POLLUTANT	ANNUAL AVERAGE Jan.1 - Dec.31				CONCENTRATION	
CITY	STREET		1973	1972	1971	1970	1969	1968	1967
CENTRAL PHOENIX	1845 E. ROOSEVELT	SULFUR DIOXIDE	8.9	9.0	11.9	13.5	16.5	9.9	----
CENTRAL PHOENIX	1845 E. ROOSEVELT	CARBON MONOXIDE	3,025	4,157	3,892	4,730	5,808	7,306	8,128
CENTRAL PHOENIX	1845 E. ROOSEVELT	NITROGEN DIOXIDE	70.1	80.5	59.1	53.8	43.9	67.4	73.8
CENTRAL PHOENIX	1845 E. ROOSEVELT	OXIDANTS	45.4	33.9	31.9	26.9	41.2	53.6	63.9
CENTRAL PHOENIX	1845 E. ROOSEVELT	TOTAL HYDRO-CARBONS	967.0	1056.0	1178.0	1113.0	1390.0	1515.0	1600.0
CENTRAL PHOENIX	1845 E. ROOSEVELT	SUSPENDED PARTI-CULATES	157.7	159.3	168.7	176.8	120.5	144.0	----

YEARLY BUS TRANSIT PATRONAGE

PHOENIX TRANSIT CORP. AND PREDECESSOR COMPANIES

YEAR	REVENUE PASSENGERS*
1960	9,309,573
1961	8,785,691
1962	6,415,263**
1963	7,813,739
1964	7,366,656
1965	6,917,424
1966	7,419,175
1967	5,180,372
1968	5,131,331
1969	4,437,837
1970	4,091,581

*Includes passengers carried on charter services.

**There was a 56-day strike.

Source: Phoenix Urban Area Public Transportation Study, DeLeuw, Cather & Co., Consulting Engineers, Chapman Press, San Francisco, Circa 1972.

Gaseous Pollutants, 1973

(Continuation of Table 11)

SAMPLER	LOCATION	POLLUTANT	ANNUAL AVERAGE Jan.1 - Dec.31 CONCENTRATION						
CITY	STREET		1973	1972	1971	1970	1969	1968	1967
CENTRAL PHOENIX	1845 E. ROOSEVELT	SULFUR DIOXIDE	8.9	9.0	11.9	13.5	16.5	9.9	----
CENTRAL PHOENIX	1845 E. ROOSEVELT	CARBON MONOXIDE	3,025	4,157	3,892	4,730	5,808	7,306	8,128
CENTRAL PHOENIX	1845 E. ROOSEVELT	NITROGEN DIOXIDE	70.1	80.5	59.1	53.8	43.9	67.4	73.8
CENTRAL PHOENIX	1845 E. ROOSEVELT	OXIDANTS	45.4	33.9	31.9	26.9	41.2	53.6	63.9
CENTRAL PHOENIX	1845 E. ROOSEVELT	TOTAL HYDRO-CARBONS	967.0	1056.0	1178.0	1113.0	1390.0	1515.0	1600.0
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Source: Phoenix Urban Area Public Transportation Study, DeLeuw, Cather & Co., Consulting Engineers, Chapman Press, San Francisco, Circa 1972.

III. Summary and Conclusions

SUMMARY AND CONCLUSIONS

The basic premise of this report has been that the availability of more electrical energy in the service areas of the four Kaiparowits utilities will facilitate urban growth. Based on past trends in the service areas, especially those parts of the service areas with the greatest population, it is argued that growth will continue to be primarily in the form of suburban sprawl.

Through the discussion of open space, pollution, and transportation a picture of present problems and issues of urban life has been presented. The inescapable conclusion is that the greater the growth in the service areas the more difficult it will be to address currently identified problems, let alone those produced by the increased growth. The multiplicity of governmental jurisdictions, especially in Southern California, makes the development of coherent, area-wide policy extremely difficult to accomplish. The Arizona service area, particularly the Phoenix SMSA does not face quite this problem simply because there are fewer people and fewer governmental jurisdictions.

The central issue is growth -- how much, how fast, and where located. One of the very basic conflicts inherent in the discussion of policy on growth was succinctly stated by the Los Angeles County General Plan (1973):

> "If growth occurs mostly in the suburbs, open lands will be lost, extension of freeways and other services will be required, and an opportunity to inject some of the vitality of this growth into older, declining areas will be lost. On the other hand, if development is limited to the inner city, there will be decreased opportunities to enjoy the single family residence life style which is so highly desired by many people."

The General Plan then argues for a "balance" between growth in the suburbs (in other words sprawl) and growth within the older urban sections. This call for balance is a fairly typical response to the conflicts over growth policy in urban areas. The net result is that growth policy decisions are preeminently political decisions. They are fought out in a political arena where the various groups and individuals with an interest at stake seek to influence the decision. In the past, those groups which benefit from relatively unrestrained growth have carried the day.

Straight-line extrapolation of present growth trends (suburban sprawl) is the most energy consuming and quality of life threatening of possibilities open to the service areas. Decisions about growth policy will be made by all levels of government, but the most basic decisions must be made at the local level. Decisions about land use, building codes, and regulation of esthetically obnoxious development are primarily made by local government. And yet there is little evidence of a willingness by local officials to implement any specific policy designed to avoid the potentially calamitous consequences of allowing present trends to continue. With an issue like growth it is impossible not to decide. A decision not to develop a growth policy is in fact a decision to allow the private sector a relatively free and uncoordinated hand in shaping future growth, and therefore the quality of urban life.

In determing how the service areas will grow, decisions about the consumption of electricity are also being made. Urban areas are the greatest consumers of all sources of energy, including electricity. At the same time, the potential for electricity conservation is also the largest in urban areas. For instance, during the period of January - August 1974 all customers of SCE reduced their consumption except the agricultural sector.

The simple fact of more growth does not necessarily translate into an identical amount of growth in electrical consumption. The amount of increase in consumption is subject to control depending upon the kind of decisions made by government and the private sector. Where a person lives, in what kind of residence, how he gets to work, and where he goes for his leisure time activity are all factors which influence rate of growth in electrical consumption. At the same time these factors are amenable to modification by appropriate public policy.

IV. Bibliography and List of Major Contacts

BIBLIOGRAPHY

Population Growth

1. California Department of Finance, "Population Estimates of California Cities and Counties," May 31, 1974.

2. California Department of Finance, "Population Projections for California Counties 1975-2020," June, 1974.

3. Southern California Rapid Transit District, Population-Employment Estimates (Xerox).

4. Southern California Association of Governments, "Migration Analysis," June, 1973.

5. ____________________, "Progress Report: Growth Forecast Revision," September 12, 1973.

6. ____________________, "Comparison of Local Government and Department of Finance Population Estimates," N. D.

7. ____________________, "Growth Forecast Selection: Environmental Assessment," January 10, 1974.

8. ____________________, "Growth Forecast Selection: SCAG Development Guide," January 10, 1974.

9. ____________________, "Growth Forecast Selection: Appendix," January 10, 1974.

10. ____________________, "SCAG's Growth Forecast Policy (D/E 2a) Compared to SCAG 90 and FEB Delphi," May 15, 1974.

Energy Growth and Electricity Demand

1. William R. Ahern, "Energy Alternatives For California: The Current Crisis, I. The Impact of Arab Oil Export Policies on the California Energy System," The Rand Corporation, December, 1973.

2. S. K. Anderson, "A Methodology For Projecting the Electrical Energy Demand in California: A Users Guide to the Model," The Rand Corporation, March, 1973.

3. Kent P. Anderson, "Some Implications of Policies to Slow the Growth of Electricity Demand in California," The Rand Corporation, December, 1972.

4. R. H. Ball and R. G. Salter, "California's Electricity Quandary: Planning For Power Plant Siting," The Rand Corporation, September, 1972.

5. Richard H. Ball, "Energy Alternatives in California: The Current Crisis, III. Allocation of Scarce Supplies," The Rand Corporation, December, 1973.

6. M. B. Berman and M. J. Hammer, "The Impact of Electricity Price Increases on Income Groups: A Case Study of Los Angeles," The Rand Corporation, March, 1973.

7. M. B. Berman, M. J. Hammer and D. P. Tihansky, "The Impact of Electricity Price Increases in Income Groups: Western United States and California," The Rand Corporation, November, 1972.

8. California Public Utilities Commission, Annual Report, 1972-1973.

9. ____________________, "Report on Electric Utility Research and Development in Areas of Aesthetic and Environmental Improvement," March, 1971.

10. ____________________, "Report On Ten-Year Forecasts of Electric Utilities' Loads and Resources," October 5, 1973.

11. ____________________, "Summary of Effectiveness of Energy Conservation Programs," September 6, 1974.

12. California Resources Agency, "Energy in California: Its Supply, Demand, Problems," January, 1973.

13. Ronald D. Doctor, "Consequences of the Present Policy of Demand Accomodation," The Rand Corporation, April, 1973.

14. ____________________, "Energy Alternatives For California: The Current Crisis: II. Conservation of Energy," The Rand Corporation, December, 1973.

15. ____________________, "Measures For Slowing Growth In Electricity Consumption," The Rand Corporation, April, 1973.

16. R. D. Doctor and K. P. Anderson, "California's Electricity Quandry: Slowing the Growth Rate," The Rand Corporation, September, 1972.

17. Federal Energy Administration, "Kaiparowits Project: Energy Analysis (Working Draft)," August 17, 1974.

18. William R. Harris, "Energy Alternatives For California: The Current Crisis IV: Regulatory Aspects of Energy Policy," The Rand Corporation, January, 1974.

19. Lester Lees, "Implications of the Growth in Demand for Commercial And Industrial Electrical Energy in the South Coast Air Basin," Environmental Quality Labs, California Institute of Technology, November, 1971.

20. Lester Lees and Mingin Philip Lo, "Time Factors In Slowing Down the Rate of Growth of Demand For Primary Energy in the United States," Environmental Quality Labs, California Institute of Technology, June 1, 1973.

21. E. J. List, "Energy Use in California," Environmental Quality Labs, California Institute of Technology, December, 1971.

22. P. K. Mazaika, "Trends of Energy Use In California And The South Coast Air Basin," Environmental Quality Labs, California Institute of Technology, May, 1973.

23. W. E. Mooz, "Energy Needs and Their Future Effects Upon Transportation," The Rand Corporation, July, 1973.

24. ____________________, "Growth Rates Within The Transportation Sector," The Rand Corporation, January, 1973.

25. ____________________, "Projecting California's Electrical Energy Demand," The Rand Corporation, January, 1973.

26. ____________________, "Transportation and Energy," The Rand Corporation, June, 1973.

27. W. E. Mooz and C. C. Mow, "California's Electricity Quandry: Estimating Future Demand," The Rand Corporation, September, 1972.

28. ____________________, "A Methodology For Projecting the Electrical Energy Demand of the Commercial Sector in California," The Rand Corporation, March, 1973.

29. ____________________, "A Methodology for Projecting The Electrical Energy Demand of the Manufacturing Sector in California," The Rand Corporation, January, 1973.

30. W. E. Mooz and R. G. Salter, "California's Electricity Demand and Supply Characteristics," The Rand Corporation, March, 1973.

31. D. N. Morris, "Energy Demand and Its Effect on the Environment." The Rand Corporation, July, 1973.

32. C. C. Mow, W. E. Mooz and S. K. Andersen, "A Methodology for Projecting the Electrical Energy Demand of the Residential Sector in California," The Rand Corporation, March, 1973.

33. Elizabeth Ralph and Lester Lees, "California's Projected Electrical Energy and Supply," Environmental Quality Labs, California Institute of Technology, March, 1972.

34. Richard G. Salter, "A Probabilistic Forecasting Methodology Applied to Elective Energy Consumption," The Rand Corporation, June, 1973.

35. R. G. Salter and D. N. Morris, "Energy Conservation in Public and Commercial Buildings," The Rand Corporation, October, 1973.

36. San Diego Gas and Electric Company, "Annual Report 1973."

37. ____________________, "Statistical Supplement to the 1973 Annual Report."

38. ____________________, Correspondence - Information Submitted to Federal Energy Administration, July 30, 1974.

39. Southern California Association of Governments, "SCAG on Energy," January 10, 1974.

40. Southern California Edison, "Effectiveness of Energy Conservation Programs," September 13, 1974.

41. ____________________, "1973 Report to California Public Utilities Commission on Ten Year Forecast of Loads and Resources," March, 1973.

42. ____________________, "1974 Report to California Public Utilities Commission on System Forecasts," 1974-2000, March, 1974.

43. ____________________, "System Forecasts 1973-1995."

44. Robert K. Yin, "The Pollution of Cities," The Rand Corporation, August, 1973.

Open Space

1. Los Angeles Regional Planning Commission, "General Plan of Los Angeles County," April, 1973.

2. San Diego County Comprehensive Planning Organization, "An Open Space System for the San Diego Region," April, 1972.

3. San Diego County Environmental Development Agency, "San Diego County General Plan, 1990," April, 1974.

4. Southern California Association of Governments, "An Outdoor Recreation and Capital Improvement Program," September, 1972.

5. ____________________, "Revised Technical Report on An Outdoor Recreation and Capital Improvement Program," December, 1973.

Pollution

1. Air Pollution Control District, County of Los Angeles, "Major Point Sources of Air Pollution in Los Angeles County," April, 1973.

2. California Air Resources Board, "Oxidant Trends in the South Coast Air Basin, 1963-1972," April, 1973.

3. ____________________, "Ten-Year Summary of California Air Quality Data, 1963-1972," January, 1974.

4. California Environmental Quality Study Council, "Environmental Quality in California: A Strategy for Action," March, 1972.

5. ____________________, "Progress Report," February, 1970.

6. California Water Projects Branch, "Fish and Wildlife Losses Due to Pesticides and Pollution from 1965 to 1969," 1970.

7. S. H. Dole and R. A. Papetti, "Environmental Factors in the Production and Use of Energy," The Rand Corporation, January, 1973.

8. Lester Lees, "Smog: A Report to the People," Environmental Quality Laboratory, California Institute of Technology, 1972.

9. R. A. Papetti and T. R. Gilmore, "Air Pollution," The Rand Corporation, February, 1971.

Transportation

1. W. T. Miholowsky, et. al., "The Regional Impact of Near-Term Transportation Alternatives: A Case Study of Los Angeles," The Rand Corporation, June, 1974.

2. Southern California Rapid Transit District, "Systems Analysis and Methodology," (Xerox), N. D.

3. ____________________, "Power Requirements," (Xerox), N. D.

4. ____________________, "Transit for Los Angeles County," July, 1974.

5. ____________________, "Rapid Transit For Los Angeles: Summary Report of Consultants' Recommendations," July, 1973.

6. ____________________, "A Public Transportation Improvement Program," March, 1974.

Regional Development Reports

1. Los Angeles Regional Planning Commission, "Environmental Development Guide," October 1, 1970.

2. San Diego Comprehensive Planning Organization, "Analysis of Radial Corridors Regional Development Alternative," October, 1973.

3. ____________________, "Analysis of the Controlled Trends Regional Development Alternative," April, 1974.

4. ____________________, "Analysis of Existing Trends Regional Development Alternative," June, 1973.

MAJOR CONTACTS

1.	Jack Nevitt	Air Pollution Control Board
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12.	Mary Bush	Southern California Edison
13.	Roger Day	" " "
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APPENDIX III-10

The Reclamation Development Act of 1974

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UCBR-MONTROSE
NOV 18 '74
Date | Initials | To

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Public Law 93-493
93rd Congress, H. R. 15736
October 27, 1974

An Act

To authorize, enlarge, and repair various Federal reclamation projects and programs, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act shall be known as "The Reclamation Development Act of 1974".

The Reclamation Development Act of 1974.

TITLE I

INCORPORATION OF PAGE, ARIZONA

Sec. 101. It is the purpose of this title to separate that unincorporated area in Coconino County in the State of Arizona, commonly known as the town of Page, Arizona, from the Colorado River storage project in order that the United States may withdraw from the ownership and operation of the town and the people of that area may enjoy self-government, and to facilitate the establishment by the people of a municipal corporation under the laws of the State of Arizona by the transfer of certain Federal property described in section 103 of this title.

Page, Arizona, Community Act of 1974.

Sec. 102. The following definitions shall apply to terms used in this title.

Definitions.

(a) The area referred to herein as Page, Arizona, includes the following described land:

Page Townsite, Arizona

GILA AND SALT RIVER MERIDIAN, ARIZONA

	Acres
Township 40 north, range 8 east:	
Section 1. All	638.94
Section 2. East half southwest quarter, southeast quarter	240.00
Section 11. East half	320.00
Section 12. All	639.38
Township 41 north, range 8 east:	
Section 25. South half southwest quarter southeast quarter, southeast quarter southeast quarter	60.00
Section 36. East half, south half northeast quarter northwest quarter, east half southwest quarter northwest quarter, southeast quarter northwest quarter, northeast quarter southwest quarter, east half northwest quarter southwest quarter, south half southwest quarter	540.00
Township 40 north, range 9 east:	
Section 4. All	639.48
Section 5. All	639.84
Section 6. All	622.74
Section 7. All	623.68
Section 8. All	640.00
Section 9. All	640.00
Section 19. East half southwest quarter, southeast quarter	240.00
Section 20. South half	320.00
Township 41 north, range 9 east:	
Section 21. West half southwest quarter, west half southeast quarter southwest quarter, southeast quarter southeast quarter southwest quarter, southwest quarter southwest quarter southeast quarter	120.00
Section 28. West half northeast quarter, northwest quarter southeast quarter northeast quarter, south half southeast quarter northeast quarter, west half, southeast quarter	590.00

PAGE TOWNSITE, ARIZONA—Continued

GILA AND SALT RIVER MERIDIAN, ARIZONA—Continued

Township 41 north, range 9 east:—Continued	Acres
Section 29. All	640.00
Section 30. All	641.20
Section 31. All	642.00
Section 32. All	640.00
Section 33. All	640.00
Total	10,717.56

Boundary drawing on file.

The boundary of Page, Arizona, is shown on drawing numbered 557–431–83, entitled "Page, Arizona, Townsite Boundary" which is on file in the Office of the Commissioner of Reclamation, Washington, District of Columbia.

(b) The term "municipality" shall mean Page, Arizona, after its incorporation as a municipality under the laws of the State of Arizona.

(c) The term "Secretary" shall mean the Secretary of the Interior.

(d) The term "municipal facilities" shall mean certain land, and the improvements thereon, in Page, Arizona, such as hospital, police, and fire protection systems, sewage and refuse disposal plants, water treatment and distribution facilities, streets and roads, parks, playgrounds, airport, cemetery, municipal government buildings, and other properties suitable or usable for local municipal purposes, including any fixtures, equipment, or other property appropriate to the operation, maintenance, replacement, or repairs of the foregoing, which are owned by the United States and under the jurisdiction of the Department of the Interior, Bureau of Reclamation, on the date of incorporation of Page, Arizona.

Land, improvements, facilities, activities and functions, transfer; leases and contracts, assignment.

SEC. 103. Upon incorporation of Page, Arizona, as a municipality under the statutes of the State of Arizona, the Secretary shall:

(a) Transfer to the municipality without cost, subject to any existing leases granted by the United States, all improved or unimproved lands within Page, Arizona, owned by the United States, which the Secretary determines are not required in the administration, operation, and maintenance of Federal activities within or near Page, Arizona, and can properly be included within the municipality under the laws of the State of Arizona, except the land to be transferred pursuant to subsection (c) hereof, and to assign to the municipality without cost any leases granted by the United States on such land.

(b) Transfer to the appropriate school district without cost all right, title, and interest of the United States to the land in block 14–A and lot 1, block 16, as shown on the United States Department of the Interior, Bureau of Reclamation drawing numbered 557–431–87, April 29, 1971, which drawing is on file in the Office of the Commissioner of Reclamation, Washington, District of Columbia, together with improvements thereon owned by the United States at the time of the transfer.

(c) Transfer to the municipality without cost all rights, title, and interest of the United States in and to any land, and the improvements thereon, which may be contained in any reversionary clause of any dedication deed for land in Page, Arizona, issued by the United States.

(d) Transfer all activities and functions of a municipal character being performed by the United States to the municipality subject to the provisions of sections 104 and 107 of this title.

(e) Transfer to the municipality without cost the municipal facilities, as defined in subsection 102(d) of this title, except as provided under subsection 104(a) of this title.

(f) Assign to the municipality without cost those contracts to which the United States is a party, and which pertain to activities or functions to be transferred under subsection (c) of this section and are properly assignable. This shall include contracts for furnishing water outside the boundaries of Page, Arizona, utilizing the municipal system: *Provided*, That the contract which the United States has executed with a private utility for furnishing and distributing electrical energy to the municipality shall be assigned to the municipality upon its request: *And provided further*, That in the assignment of the contract for the operation of the Page Hospital the operating fund balance under said contract, together with all hospital accounts receivable, shall be transferred to the municipality for the same purpose as a part of the assignment of said contract.

Water supply, contract.

SEC. 104. There is hereby reserved for the Glen Canyon unit, Colorado River storage project, the consumptive use of not to exceed three thousand acre-feet of water per year from Lake Powell, of which not to exceed two thousand seven hundred and forty acre-feet of consumptive use of water are hereby assigned to the municipality, consistent with the Navajo Tribal Council resolution numbered CJN-50-69, dated June 3, 1969: *Provided*, That upon incorporation the municipality shall enter into a contract satisfactory to the Secretary covering payment for and delivery of such water pursuant to the Colorado River Storage Project Act of June 11, 1956 (70 Stat. 105), which contract shall among other things provide that:

43 USC 620.

(a) The reservation and assignment of the consumptive use of water from Lake Powell under this section shall be subject to the apportionments of consumptive use of water to the State of Arizona in article III of the Colorado River Compact and article III(a)(1) of the Upper Colorado River Basin Compact.

(b) Title to the water pumping and conveyance systems within the Glen Canyon Dam and powerplant necessary to supply water to the municipality for culinary, industrial, and municipal purposes shall be retained by the United States until the Congress provides otherwise.

(c) Such retained facilities shall be operated and maintained by the Secretary at the expense of the United States until termination of the fifth fiscal year following the year of incorporation. Not to exceed two thousand seven hundred and forty acre-feet of water per annum or three million gallons of water in any twenty-four-hour period, will be pumped by the United States from Lake Powell to the water treatment plant, or to such intermediate points of delivery as shall be mutually agreed upon by the municipality and the United States for use by the municipality.

(d) Beginning with the sixth year following incorporation and continuing through the tenth year, the municipality shall in each year pay to the United States proportionately increasing increments of the annual costs, including depreciation of the pumping equipment, involved in subsection (c) above with the objective that following the close of said tenth year the municipality shall thereafter bear such costs in total, according to the following schedule:

Year following incorporation:	Portion of cost in subsection (c) of section 104 to be paid to United States each year by municipality (per centum)
Sixth	20
Seventh	40
Eighth	60
Ninth	80
Tenth	80
Thereafter	100

(e) Upon incorporation and at all times thereafter, the municipality shall bear all costs for operation, maintenance, and replacement of the municipal water system beyond Glen Canyon Dam and powerplant, including but not limited to filtration, treatment, and distribution of water supplied pursuant to the water service contract with the United States.

Community programs, completion.

SEC. 105. As soon as reasonably practicable after incorporation of the community, the Secretary is hereby authorized to complete all or any part of the following work which has not been completed at the date of incorporation.

(a) Take census of population of the municipality within one year following incorporation.

(b) Repair existing twelve-inch water supply line, if inspection determines this is necessary.

(c) Paint interior of water storage reservoirs.

(d) Seal coat paved streets in municipality.

(e) Install water sprinkler system in Page cemetery.

(f) Improve streets, install curbs, gutters, and sidewalks as follows:

(1) North Navajo Drive:

(i) Pave streets to seventy-foot width from Ninth Avenue to relocated intersection of Aero Avenue and sixty-one-foot width from Aero Avenue to Tenth Avenue.

(ii) Place curb, gutter, and sidewalk on east side of North Navajo Drive from Aero Avenue to Tenth Avenue.

(2) Aero Avenue from North Navajo Drive to Future Street:

(i) Widen existing thirty-foot paved width to seventy-foot paved width.

(ii) Place curb, gutter, and sidewalk on both sides of street.

(3) Tenth Avenue from Future Street to Sandstone Street:

(i) Construct new pavement on north half of street and overlay south half of street.

(ii) Place curb and gutter only on north side of street.

(4) Future Street—Approximately two thousand one hundred and fifty feet beginning at Tenth Avenue and bordering east side of block 101 as shown on Page townsite and block plats:

(i) Pave street to fifty-two-foot width.

(ii) Place curb, gutter, and sidewalk on west side of street and curb and gutter only on east side of street.

(5) Hopi Avenue from Oak Avenue to west boundary of block 101:

(i) Pave street to forty-two-foot width.

(ii) Place curb, gutter and sidewalk on north side.

(iii) Place curb and gutter only on south side.

(g) Construct paved access road from United States Highway Numbered 89 to site of new sanitary landfill to be located in the northwest quarter, section 20, township 41 north, range 8 east, Gila and Salt River meridian, Arizona: *Provided*, That in the performance of the work authorized in this section, the Secretary may either cause the work to be done or transfer funds to the municipality for this purpose after ascertaining that each segment of work will be accomplished by a date certain and to standards satisfactory to the Secretary.

Payment to municipality.

SEC. 106. (a) Upon incorporation the Secretary is authorized to make a lump-sum payment of $500,000 to the municipality as assistance to the municipality in meeting the expenses of police and fire protection facilities and services, sewage system, refuse disposal, electrical distribution system, water treatment and distribution, streets and roads, library, park, playgrounds and other recreational facilities, municipal government buildings, and other properties and services required for municipal purposes.

(b) To make a lump-sum payment of $50,000 to the municipality for improvements to the Page Hospital.

Federal personnel, services provided to municipality.

SEC. 107. Upon incorporation, the United States will provide to the municipality, upon its request, the services of Federal personnel, while they are employed by the United States in the operation and maintenance of the Glen Canyon unit of the Colorado River storage project, to assist in the transition from a federally administered community to a self-governing municipal corporation: *Provided*, That such assistance shall be for a maximum of six months following the date of incorporation: *And provided further*, That the total number of such employees shall be limited to ten at any time.

Limitations.

Funds, prohibition of additional use.

SEC. 108. (a) Except as herein specifically provided, no assets of the Colorado River storage projects or moneys of the Upper Colorado River Basin Fund shall be utilized after incorporation of the municipality for carrying out the provisions of this Act.

Transfer of funds.

(b) At the election of the municipality, the United States shall make electric power and associated energy available to the municipality from the Colorado River storage project at the 69 kilovolt bus of the existing power substation at scheduled rates effective from time to time for resale by the municipality to an electric utility: *Provided*, That the sale agreement between the municipality and such utility is completed before August 1, 1976: *And provided further*, That in lieu of such purchase and resale, there is hereby authorized to be appropriated from the Upper Colorado River Basin Fund and thereupon transferred to the municipality the amount necessary for the municipality to acquire the electric distribution facilities in Page, Arizona, in the event the municipality decides before August 1, 1976, to acquire said facilities through the exercise of its powers of eminent domain or the amount necessary for the municipality to acquire such facilities in accordance with the terms and conditions of the contract with the utility supplying the electricity. in the event the municipality exercises the option in said contract to acquire said electric distribution facilities: *Provided*, That the municipality agrees to repay with interest the amount of the funds so transferred in twenty equal annual installments: *Provided*, That the funds so repaid and the accrued interest thereon will be deposited in the Treasury to the credit of the aforesaid Upper Colorado River Basin Fund. The interest rate used for computing interest on the unpaid balance of funds transferred to the municipality for purposes of this subsection shall be determined by the Secretary of the Treasury, as of the beginning of the fiscal year in which the incorporation of Page, Arizona, occurs, on the basis of the computed average interest rate payable by the Treasury upon its outstanding marketable public obligations which are neither due nor callable for redemption for fifteen years from date of issue.

Navajo Tribe, transfer of land to be held in trust.

SEC. 109. The Secretary of the Interior is authorized to transfer to the United States to be held in trust for the Navajo Tribe title to a tract of land situated within the southeast quarter of the southeast quarter, section 8, the southwest quarter, section 9, section 16, the east half of the northeast quarter, section 17, section 21, and the northeast quarter of the northeast quarter, section 28, all in township 41 north, range 9 east, Gila and Salt River meridian, Coconino County, Arizona, and containing eight hundred and eight acres, more or less, of which the particular description and drawing (Numbered 557-431-38 "Navajo Tribe—Antelope Creek Recreation Development Area Survey Traverse" dated May 22, 1969) are on file and available for public inspection in the office of the Bureau of Reclamation, Department of the Interior. The transfer of title to such land is made in consideration of Navajo Council Resolution Numbered CNJ-50-69 dated June 3, 1969, and with the understanding that the land so transferred shall thereafter constitute a part of the Navajo Reservation and shall be subject to all laws and regulations applicable to that reservation.

SEC. 110. The Congress hereby directs the Secretary of the Interior to facilitate the effectuation of Navajo Tribal Council Resolutions

CD 108–68 and CJN–50–69, subject to the provisions of the Colorado River Basin Project Act (82 Stat. 885).

43 USC 1501.

Sec. 111. The Secretary is hereby authorized, subject only to the provisions of this title to perform such acts, to delegate such authority, and to prescribe such rules and regulations, and establish such terms and conditions as he may deem necessary and appropriate for the purpose of carrying out the provisions of this title.

Funding.
43 USC 620.

Sec. 112. The Upper Colorado River Basin Fund established pursuant to section 5 of the Act of April 11, 1956 (70 Stat. 105), shall be utilized as appropriate for carrying out the provisions of this title: *Provided*, That the total expenditures from the fund shall not exceed $4,000,000. Payments made under the provisions of section 105 and section 106 of this title, and transfer, made under the provisions of subsection 108(b) will be made from revenues accruing to said basin fund from the sale of power from the Upper Colorado River storage project.

Termination date.

Sec. 113. All authority of the Secretary under sections 101 through 112 of this title shall terminate five years following date of enactment unless incorporation of Page, Arizona, shall previously have been achieved.

Sec. 114. This title may be cited as the "Page, Arizona, Community Act of 1974".

APPENDIX IV - 1

Statutes, Regulations and Contracts

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Statutes, Regulations and Contracts

Federal:

(CFR - Code of Federal Regulations; USC - United States Code; PL - Public Law).

National Environmental Policy Act of 1969 (83 Stat. 852, 42 USC 431 et seq.).

Bureau of Reclamation: Contract for Water Service from Lake Powell (Contract No. 14-06-400-5139). Federal Coal Leases held by Resources Co. et al.

Fossil fuel burning installations - 40 CFR, Part 60.

Federal ambient air quality standards - 42 CFR, Part 410.

Clean Air Act of 1970, as amended.

Prevention of significant air quality deterioration, Environmental Protection Agency (Federal Register, Vol. 38, No. 235, December 5, 1974).

(Control of radioactive air pollution from coal burning) - Atomic Energy Act of 1954 (68 Stat. 919; 43 USC, Sec. 2011, et seq.; 10 CFR, Part 20).

(Objects affecting navigable air space (smokestacks, buildings) - Federal Aviation Act of 1958, PL 85-726, August 23, 1958 (72 Stat. 749, 797; 49 USC 1348, 1501; 14 CFR, Part 77).

Highway development and construction - PL 85-767 of August 27, 1968 (72 Stat. 885; Title 23 USC Chapter 1, Section 109; 23 CFR 1.3, .4).

Interstate and Defense Highway System, Federal-aid Highways - 23 USC, Chapter 1, Section 109.

Federal Environmental Pesticide Control Act (1972), PL 92-516; 7 USC 136.

Requirements relating to preservation of the quality of interstate water are outlined in the Federal Water Pollution Control Act. These requirements are under authority of Utah Code Section 26-15-4 and 5, and Section 73-14-1 to 13 (Utah Code, annotated 1953, as amended).

The Fish and Wildlife Coordination Act (48 Stat. 401 as amended, 16 USC 661 et seq., in Section 662) requires that ". . . whenever the

The Endangered Species Act of 1973 (Public Law 93-205).

Bald Eagle Protection Act - 16 USC 668-668d.

Executive Order 11593 of 1971 (36 FR 8921).

Archaeological Preservation Act of 1974 (88 Stat. 174, PL 93-291, 16 USC 469a-1, 2).

National Historic Preservation Act of 1966.

Federal Antiquities Act of 1906 (24 Stat. 225, 16 USC 431 et seq.).

Historic Sites Act of 1935 (49 Stat. 666, 16 USC 461 et seq.).

National Historic Preservation Act of 1966 (80 Stat. 915, 16 USC 470 et seq.), the

Occupational Safety and Health Act of 1970, approved December 29, 1970 (84 Stat. 1590; 5 USC 7902; 29 USC 651-678; E.O. 11612 of July 26, 1971; 36 FR 13891).

Solid Waste Disposal Act, as amended (42 USC 3251).

Noise Control Act of 1972 (42 USC 4091).

Executive Order No. 11752 of December 17, 1973 (38 FR 32793).

Communication stations - Act of June 19, 1934 as amended (48 Stat. 1082; 47 USC 303; 47 CFR 1.70).

Water plants, pipelines, etc. - Act of February 15, 1901 (31 Stat. 790; 43 USC 959; 43 CFR, Sub-part 2873), as applied to NPS in 43 CFR 2801.1-7.

Safety standards for underground coal mines - Federal Coal Mine Health and Safety Act of 1969 (83 Stat. 745; 30 USC 811; 30 CFR, Part 75).

Safety standards for open pit metal and nonmetallic mines (limestone) - Sec. 6 of the Federal Metal and Nonmetalic Mine Safety Act of September 16, 1966 (PL 89-577; 80 Stat. 774; 30 USC (725 30 CFR, Part 55).

Regulations governing the Geological Survey's authority concerning coal-mining operations are set forth in 30 CFR, Part 211.

Coal leases - Act of February 25, 1920 (41 Stat. 437; 30 USC 181 et seq.), as amended and supplemented; and more specifically Secs. 2-8 (41 Stat. 438 et seq.; 30 USC 201-208, as amended; and 43 CFR, Parts 23 and 3500); and Secretary's (of the Interior) Order No. 2948 dated October 6, 1972.

Department of the Interior regulations, 43 CFR, Part 23, provide for protection and conservation of nonmineral resources during discovery, development, surface mining, and on-site processing of minerals under permits, leases, or contracts issued under the Mineral Leasing Act of February 25, 1920, as amended (30 USC 181-287) for new leases and readjustments of lease terms for existing leases; and under the Materials Act of July 31, 1947, as amended (30 USC 601-604); et al.

Tramroads for mine access, coal haul road, conveyor belt, etc. - Act of January 21, 1895 (28 Stat. 635; 43 USC 956; 43 CFR, Part 2810).

Roads and highways - (23 USC 107, or RS 2477; 43 USC 932; 43 CFR, Part 2820).

Power transmission lines - Act of March 4, 1911 (36 Stat. 1253; 43 USC 961; 43 CFR, Part 2850).

Recreation and public purposes lease for sanitary land fill area, recreation development, educational purposes, etc. - Act of June 14, 1926 (44 Stat. 741; 43 USC 869-4; 43 CFR, Sub-parts 2740 and 2912).

Special land use permits for purposes not specifically provided for by existing law - (R.S. 446, 453 and 2478, as amended; 43 USC 1, 2, 1201; Act of July 14, 1960 (70 Stat. 506; 43 USC 1361-1364; 43 CFR, Part 2920).

U.S. Forest Service:

36 CFR Part 252 (Federal Register, Vol. 39, page 31317 August 28, 1974).

36 CFR Part 251.1

30 Stat. 34 (as amended and supplemented, 16 USC 460 471-594, 616, 694 and 1131-1135; 33 USC 701; 7 USC 1010-1013a; 36 CFR 200.3 et seq.).

National Park Service:

36 CFR, Part 4.11

36 CFR, Part 800.10

State of Utah:

Utah State Division of Lands:

Mineral Leases - (Utah Code annotated, 1953, as amended 65-1-18). Permits and easements on State lands for power transmission lines, roads, water pipelines, etc. - (Utah Code Annotated, 1953, as amended, 65-2-1).

Utah State Engineer:

Utah Code Annotated, 1953, as amended.

Water Rights Division:

Utah State Division of Health, Bureau of Environmental Health:

Water Quality Section:

Control of water pollution - (Utah Code Annotated, 1953, as amended, Chapter 73-14, especially 73-14-5 to 73-14-13).

General Sanitation Section:

Control of solid waste - (Utah Code Annotated, 1953, as amended, Title 26.

Code of Air Conservation Regulations, State of Utah, Dept. of Social Services, Division of Health, January 24, 1972. ibid.

Executive Order No. 11752

Title 10, Utah Code, Chapter II
Title 10, Utah Code, Chapter 7, Section 14
Title 26, Utah Code, Chapter 14, Section 4
Title 10, Utah Code, Chapter 15
Title 10, Utah Code, Chapter 9

Utah Antiquities Act 63-8-21 through 63-11-31 Utah Code Annotated, 1953.

APPENDIX IV-2

Statutory and Administrative Requirements

APPENDIX IV-2

Statutory and Administrative Requirements

Transmission system impact area

The participants would comply with all statutory and administrative requirements of the United States Government and the State of Utah, Arizona, Nevada and California including, but not limited to, the following:

Clean Air Act of 1970 as amended.

Federal and State ambient air quality standards established for Arizona, California, Nevada, Utah.

Air quality standards of Occupational Safety and Health Administration (OSHA), Arizona, California, Nevada, and Utah apply to the environment in and around working areas for the transmission line.

Federal Water Pollution Control Act of 1972 as amended, and the Arizona, California, Nevada and Utah codes on water pollution control.

The Noise Control Act of 1972 and State counterparts.

The National Environmental Policy Act of 1969.

The Endangered Species Act of 1973.

The Bald Eagle Act as amended 1966.

The Migratory Bird Treaty Act as amended.

The Fish and Wildlife Coordination Act as amended.

Interstate and Defense Highway System (Title 23, United States Code).

Arizona, California, Nevada and Utah regulations and codes pertaining to wildlife species in these states.

The Federal Antiquities Act of 1906.

The Archaeological Preservation Act of 1974.

Historic Sites Act of 1935.

National Historic Preservation Act of 1966.

Executive Order 11593, May 13, 1971, "Protection and Enhancement of the Cultural Environment."

Archaeological Preservation Act of 1974; amends Reservoir Salvage Act of 1960.

Arizona Archaeological, Paleontological and Historical Preservation Act.

Code of Federal Regulations, Preservation of American Antiquities.

California Penal Code, Antiquities; Nevada, Antiquities Act; Utah Antiquities Act; and California, Public Resource Code.

Code of Federal Regulations, Title 43.

Code of Federal Regulations, Title 36.

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